CORPORATE PLAN FOR UTILIZING CAD/CAM

PHASE I REPORT

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CORPORATE PLAN FOR UTILIZING CAD/CAM
PHASE I REPORT

Prepared For:

AVCO CORPORATION

NOVEMBER 1981

CORPORATE PLAN FOR UTILIZING CAD/CAM
PHASE I REPORT

CONTENTS

CORPORATE PLAN FOR UTILIZING CAD/CAM
PHASE I REPORT

EXHIBITS

1 INTRODUCTION

I INTRODUCTION

A. OBJECTIVES

- The purposes of this report are to:

  - Structure the current Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) status of eight of AVCO's manufacturing divisions based upon visits by the study team from January 20 to March 6, 1981, and visits to review the draft report from May 19 to June 16, 1981.

    . The divisions include Aerostructures, New Idea, Lycoming/Williamsport, Lycoming/Stratford, Electronics, Systems, Metalworking Laser, and Specialty Materials.

  - Identify the near-term (1981-1982) needs for CAD/CAM for each division as perceived by that division's management.

  - Document the corporate study team's initial assessment for CAD/CAM development through 1982.

    . The study team consists of:

      . K.J. Panzarella, Chairman.

      . N. Bernstein, Project Manager.

. R. Insinga, Project Advisor.

. D. Eckber, Project Advisor.

. D. Penning, Consultant.

- Prepare conclusions and recommendations for CAD/CAM at AVCO divisions.

- Provide an initial basis for further development of an AVCO corporate CAD/CAM five-year plan.

B. METHODOLOGY

- The primary sources of information for this report were CAD/CAM plans that have been documented by each division and discussions between the study team and divisional management during the plant visits.

- Secondary information sources include:

  - Presentations made to the study team during its visits to the divisions.

  - Observations by the study team based upon tours of the divisional engineering and production facilities.

  - Published product and divisional literature that is routinely used for public relations purposes.

- The revised report has been prepared by the study team subsequent to the completion of the divisional visits.

  - It is current up to and including the information that has been received from the divisions as of June 16, 1981.

II EXECUTIVE SUMMARY

II EXECUTIVE SUMMARY

A. INTRODUCTION

- This Executive Summary contains:

  - A top-down view of all eight AVCO manufacturing divisions regarding the:

    . Current status of CAD/CAM. (Note: CAD/CAM includes Manufacturing Control Systems (MCS).)

    . 1981-1982 CAD/CAM needs as perceived by each divisional management.

    . Initial prospects for CAD/CAM development in the 1981/1982 time frame as judged by the Corporate Study Team.

  - A comparison of the eight divisions' status, needs, and prospects for near-term CAD/CAM development.

  - The background of AVCO's overall CAD/CAM activities against which each of the eight individual divisions can measure its relative position within the AVCO Corporation.

- The fundamental information that is needed for development of an AVCO Corporate CAD/CAM five-year plan.

- During Phase I of this multi-phase corporate CAD/CAM project, the Study Team visited each of the following AVCO divisions:

  - Lycoming/Stratford (January 20-21, February 12, May 27).

  - Systems (February 5, May 21).

  - Specialty Materials (February 6).

  - Metalworking Laser (February 6).

  - Aerostructures (February 16, 17, June 4).

  - New Idea (February 20, June 3).

  - Electronics (February 25, June 16).

  - Lycoming/Williamsport (March 6, May 20).

- The purposes of these divisional visits are detailed in Exhibit II-1, Divisional Checklist.

  - The checklist identifies for each division what has been accomplished and what data had been collected by the Study Team as of June 16, 1981.

- Government, university, and industry programs have been researched in parallel with the Study Team's efforts.

  - Activities and projects that relate to AVCO divisional needs have been identified.

EXHIBIT II-1

AVCO DIVISIONAL VISIT CHECKLIST
1981

WHAT	STRAT-FORD	SYSTEMS	WILLIAMS PORT	NEW IDEA	ELEC-TRONICS	AERO STRUC-TURES	SPEC. MATLS. LOWELL	MTLW. LASER EVERETT
• DAY AND DATE(s) OF VISITS	1-20/21 2-12 5-27	2-5 5-21	3-6 5-20	2-20 6-3	2-25 6-16	2-16/17 6-4	2-6	2-6
• KEY CONTACT	MEINKING	HAYES	MOFFETT	DOMINIK	WESTER	SCHU-MACHER	HOFFMAN	FEINBERG
• OTHER CONTACTS - PRODUCTION	KUNZE (ACTING)	McCARD	BOWER	GOETHE	-	LINHART	N/A	FOUST
• OTHER CONTACTS - ENGINEERING	HOFF-MAN	FITZ-GERALD	DUKE	RONAYNE	COOK	OTTEN-VILLE	-	SIRCHIS
• OTHER CONTACTS - DATA PROCESSING	THOMP-SON	BIBAUD	GORE	SOWAR	SPRING-ER	PLAMON-DON	N/A	N/A
• REVIEWED STUDY OBJECTIVES	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE
• QUESTIONNAIRE COMPLETED	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	PARTIALLY	N/A	N/A

EXHIBIT II-1 (CONT.)

AVCO DIVISIONAL VISITS CHECKLIST

1981

WHAT	STRAT-FORD	SYSTEMS	WILLIAMS PORT	NEW IDEA	ELEC-TRONICS	AERO STRUC-TURES	SPEC. MATLS. LOWELL	MTLW. LASER EVERETT
• CAD/CAM PLANS RECEIVED	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	N/A	PAR-TIALLY	N/A	N/A
• CAD/CAM PLANS REVIEWED	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	N/A	COM-PLETE
• BACKGROUND DATA RECEIVED	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE
• TOUR OF PRODUCTION FACILITIES	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE
• TOUR OF ENGINEERING FACILITIES	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE
• PRODUCTION/CAPA-BILITIES LITERATURE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE

EXHIBIT II-1 (CONT.)

AVCO DIVISIONAL VISITS CHECKLIST

1981

WHAT	STRAT-FORD	SYSTEMS	WILLIAMS PORT	NEW IDEA	ELEC-TRONICS	AERO STRUC-TURES	SPEC. MATLS. LOWELL	MTLW. LASER EVERETT
• ORGANIZATION CHARTS	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	N/A	N/A
• ENGINEERING EQUIPMENT LISTING	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	N/A	N/A
• PRODUCTION EQUIPMENT LISTING	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	-	N/A	N/A
• EQUIPMENT INVESTMENT PLANS/ BUDGETS	PAR-TIAL	COM-PLETE	-	-	COM-PLETE	-	-	-
• REVIEW/REVISE PHASE I REPORT DRAFT	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	COM-PLETE	-	-

- The timing of these related CAD/CAM activities has been documented.

- This information was delivered to the AVCO Study Team (as part of the Phase I deliverable items) on March 31, 1981.

- Divisional CAD/CAM plans have been analyzed by the Study Team.

  - This report documents the results of these analyses.

  - The initial report draft was prepared by the Corporate Study Team.

- The study Report drafts were delivered to each division in four parts:

  - I Introduction.

  - II Executive Summary.

  - III/X The division's individual report; i.e. one of:

    . III Aerostructures.

    . IV New Idea.

    . V Lycoming/Williamsport.

    . VI Lycoming/Stratford.

    . VII Electronics.

    . VIII Systems.

    . IX Metalworking Laser.

. X Specialty Materials.

- The Appendix.

- CAD/CAM terminology is confusing and contains much jargon. To alleviate confusion and increase the ability of the Study Team and divisions to communicate, the CAD/CAM concept is illustrated in Exhibit II-2, while specific terms are defined in the Appendix.

- A corporate presentation was made in Greenwich on May 18, 1981.

  - This presentation was based upon the initial Phase I report draft.

- Visits were made to each division (except for Specialty Materials Division and Metalworking Lasers Divisions) in order to:

  - Review the Corporate presentation.

  - Review and revise the Phase I report draft.

- This final Phase I report incorporates the comments and updates that each division has made to the initial report draft.

  - In addition, the measurements of CAD/CAM status and perceived needs were changed to reflect only those functions that are applicable to each division's unique requirements, as determined by the division.

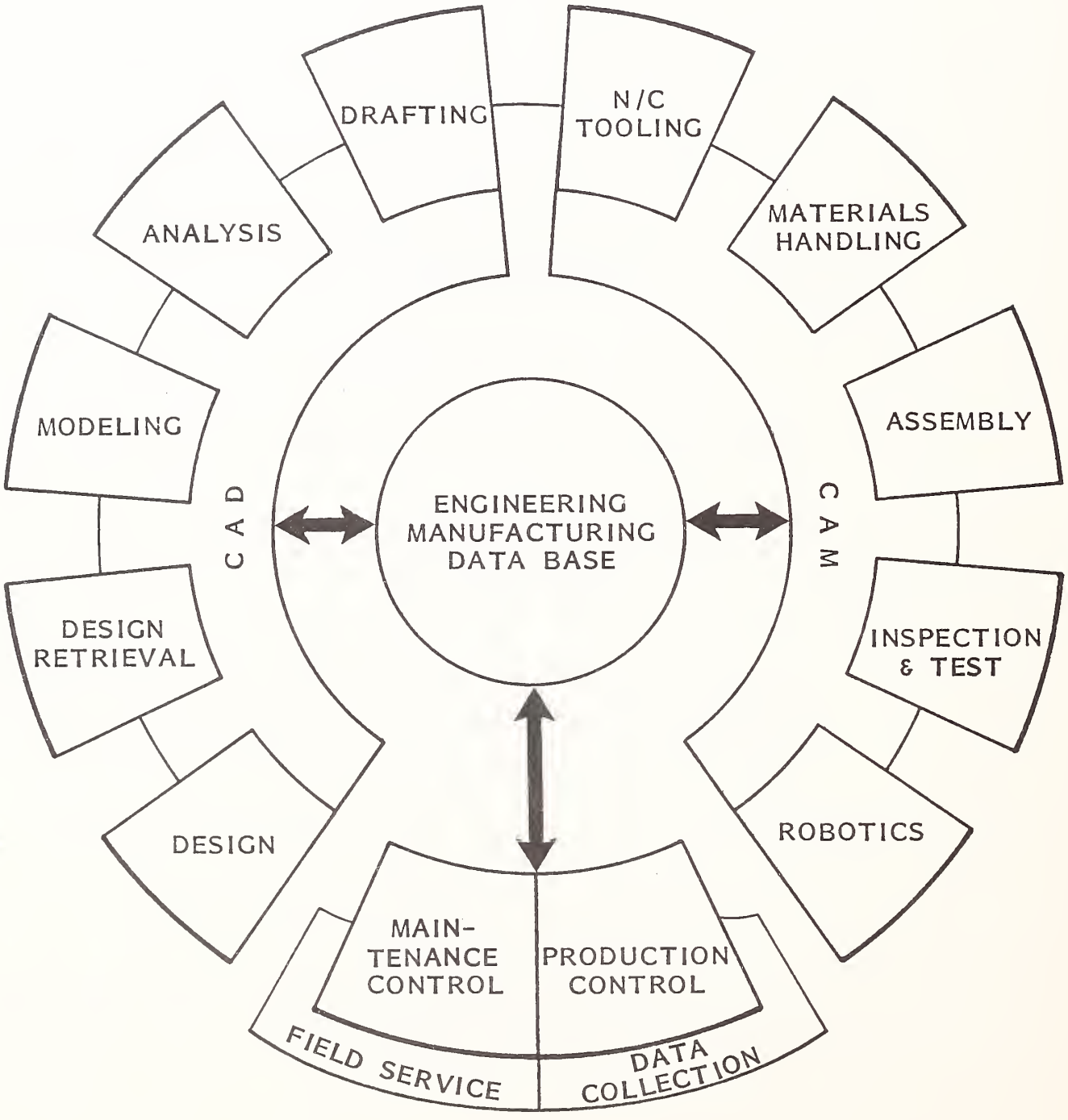
- The benefits that are expected from this final Phase I report include:

  - Standard documentation of divisional CAD/CAM status.

  - Definitions of divisional CAD/CAM perceived needs for 1981/1982.

EXHIBIT II-2

CAD/CAM INTEGRATION



- Comparisons between divisions regarding their relative status and near-term needs.

- Stimulation of mutual assistance between divisions on CAD/CAM developments.

- A structural basis for development of AVCO corporate and individual divisional five-year CAD/CAM plans.

- Standardization of CAD/CAM concepts and terminology throughout the corporation.

B. DIVISIONAL CAD/CAM STATUS

1. CAD STATUS

- Exhibit II-3 shows the current activities of each of the eight manufacturing divisions with regard to CAD functions.

  - A zero in the matrix indicates that there is no current activity.

  - A one indicates that this function is currently being studied or investigated by the division.

  - A 1.5 indicates that the function is being implemented.

  - A two indicates that the function has been installed and is currently being used within the division.

- Details about these functions for each division are contained in the chapter that is specific to that division.

EXHIBIT II-3

AVCO DIVISIONAL CAD STATUS - (AS OF JUNE 16, 1981)

FUNCTION	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
SYSTEM EVALUATION	2	1	2	1	2	1	X	1	10	2
SYSTEM GROWTH	1	X	2	0	1	X	X	X	4	9
SYSTEM INSTALLATION	2	X	2	0	2	X	X	X	6	7
DESIGN-MECHANICAL	2	1	2	0	X	1	X	1	7	6
DESIGN-ELECTRICAL	2	1	X	0	2	X	X	X	5	8
DESIGN-ARCHITECTURAL	2	X	2	2	2	X	X	1	9	3
DESIGN-TOOLING	2	1	2	0	X	1	X	X	6	9
DRAFTING	2	1	2	0	2	1	X	1	9	3
ANALYSIS-FEA	2	2	2	2	X	0	2	X	10	2
ANALYSIS-THERMAL	2	2	X	0	X	0	X	X	4	9
ANALYSIS-IC	0	2	X	0	2	0	X	X	4	9

0 = NO ACTIVITY, 1 = STUDY, 1.5 = BEING INSTALLED CURRENTLY, 2 = INSTALLED, X = NOT APPLICABLE

EXHIBIT II-3 (CONT.)

AVCO DIVISIONAL CAD STATUS - (AS OF JUNE 16, 1981)

FUNCTION	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
ANALYSIS-3D	2	1	2	0	X	0	X	1	6	7
ANALYSIS-OTHER	2	2	2	0	2	2	X	X	10	2
DESIGN RETRIEVAL	2	1	2	0	2	0	X	X	7	6
TAPE PREPARATION	2	2	2	1	2	0	X	X	9	3
TOOL OPTIMIZATION	0	0	2	0	2	0	X	X	4	9
AUTOMATIC LAYOUT/ NESTING	X	1	2	1	X	X	X	X	4	9
ENGINEERING DATA BASE	1.5	1	2	2	1	0	X	X	7.5	5
MANUFACTURING PROCESS DOC.	0	1	1	0	X	0	X	X	2	10
GEOMETRIC MODELING	2	2	2	2	2	2	0	X	12	1
OTHER	1	1	1	0	2	1	X	X	6	7
DIVISION TOTALS	31.5	23	34	11	26	9	2	5	141.5	-

0 = NO ACTIVITY, 1 = STUDY, 1.5 = BEING INSTALLED CURRENTLY, 2 = INSTALLED, X = NOT APPLICABLE

- The bottom row of Exhibit II-3 shows that Aerostructures leads all the divisions for absolute level of activity in CAD.

  - Stratford is second, while Electronics ranks third.

  - The other divisions do not have CAD installations, but most of them are actively investigating a CAD system.

- The highest level of functional activity for all AVCO divisions in the CAD area is in geometric modeling, as shown in the right column (Score) of Exhibit II-3.

  - Exhibit II-4 lists the six functional activities in CAD that currently have the greatest levels of activity across all divisions.

  - Various analyses have the next highest level of activity for all divisions.

- The function which has the least activity of the AVCO divisions is manufacturing process documentation directly from the CAD data base.

2. CAM STATUS

- Exhibit II-5 lists the current CAM activities of each of the eight divisions. The numbering logic is the same as is used for Exhibit II-3.

- As is the case in CAD activities, Aerostructures leads all the other divisions in absolute level of CAM activities.

  - Lycoming/Stratford is second in level of CAM activity.

  - The general level of CAM activity is lower than for CAD and MCS across all divisions.

EXHIBIT II-4

1981 DIVISIONAL CAD/CAM

STATUS SUMMARY BY FUNCTION

CAD	ALL DIVISIONS IN ORDER OF ACTIVITY LEVELS
1	GEOMETRIC MODELING
2	EVALUATION OF CAD SYSTEMS, FINITE ELEMENT ANALYSIS
3	DRAFTING, ARCHITECTURAL DESIGN* N/C TAPE PREPARATION
CAM	ALL DIVISION IN ORDER OF ACTIVITY LEVELS
1	N/C MACHINE TOOLS, MECHANICAL INSPECTION AND TEST SYSTEMS
2	CNC MACHINE TOOLS, AUTOMATED SYSTEMS TESTING
MANU-FACTURING CONTROL	ALL DIVISIONS IN ORDER OF ACTIVITY LEVELS
	PROCESS AND ROUTING, MATERIAL CONTROL, BILL OF MATERIALS

* INCLUDES PIPING AND BUILDING LAYOUT

EXHIBIT II-5

AVCO DIVISIONAL CAM STATUS (AS OF JUNE 16, 1981)

FUNCTION	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
N/C MACHINE TOOLS	2	2	2	2	X	2	X	X	10	1
CNC MACHINE TOOLS	2	2	2	0	X	2	X	X	8	2
DNC MACHINE TOOLS	1	X	1	0	X	0	X	X	2	6
FMC	2	X	1	0	X	2	X	X	5	3
AUTOMATED STORAGE/RETRIEVAL	2	0	0	0	X	0	X	X	2	6
AUTOMATED WAREHOUSE	0	0	0	0	X	0	X	X	0	9
TOOLING AND GAUGE SYSTEM	1.5	0	0	0	X	0	X	X	1.5	7
GUIDED VEHICLE SYSTEM	0	0	0	0	X	0	X	X	0	9
ROBOT- MATERIAL HANDLING	0	0	0	0	X	0	X	X	0	9
OTHER- MATERIAL HANDLING	0	0	0	0	X	0	X	X	0	9

0 = NO ACTIVITY, 1 = STUDY, 1.5 = BEING INSTALLED CURRENTLY, 2 = INSTALLED, X = NOT APPLICABLE

EXHIBIT II-5 (CONT.)

AVCO DIVISIONAL CAM STATUS (AS OF JUNE 16, 1981)

FUNCTION	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
ROBOT-ASSEMBLY	0	0	1	0	0	0	X	X	1	8
OTHER-ASSEMBLY	0	0	2	0	2	0	X	X	4	4
ELECTRONIC TEST	0	2	1	0	2	0	X	X	5	3
MECHANICAL TEST	2	2	2	0	2	0	2	X	10	1
SYSTEMS TEST	2	2	0	0	2	2	X	X	8	2
PROCESS TEST	0	0	1	0	X	1	2	X	4	4
WELDING ROBOT	1	0	0	1	X	1	X	X	3	5
PAINTING ROBOT	0	0	1	0	X	1	X	X	2	6
OTHER ROBOT	0	0	1	0	2	1	X	X	4	4
FACILITIES MANAGEMENT	0	0	2	0	1	0	0	X	3	5
DIVISION TOTALS	15.5	10	17	3	11	12	4	0	72.5	-

0 = NO ACTIVITY, 1 = STUDY, 1.5 = BEING INSTALLED CURRENTLY, 2 = INSTALLED, X = NOT APPLICABLE

- The only division that has no CAM activity at all is the Metalworking Laser Division.

- As shown in Exhibit II-4, the highest level of CAM functional activity for all divisions is numerically controlled machine tools (NC) and computer controlled mechanical inspection and test systems.

- CNC machine tools rank at the same level of activity with the systems test activities.

  - Systems test includes both testing engines and checking out electronics systems.

- Flexible machining centers (FMC) are installed at both the engine manufacturing divisions.

3. MANUFACTURING CONTROL STATUS

- Exhibit II-6 lists the current activities of each of the divisions in the manufacturing control systems area.

  - The bottom row of the matrix shows that Electronics has the highest current level of manufacturing control systems installations.

  - Lycoming/Stratford and Aerostructures rank second highest.

- Bill of material, material control, and process and routing are equally at the highest levels of MCS activity, as can be seen from Exhibit II-4.

C. DIVISIONAL CAD/CAM STATUS EVALUATION

- Not all functional activities are equally applicable to every division.

EXHIBIT II-6

AVCO DIVISIONAL MANUFACTURING CONTROL STATUS (AS OF JUNE 16, 1981)

FUNCTION	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
BILL OF MATERIAL	2	1	2	2	2	2	X	X	11	1
MATERIAL CONTROL	2	1	2	2	2	2	X	X	11	1
MATERIALS REQUIREMENTS PL.	2	1	1	2	2	2	X	X	10	3
PURCHASING	1	1	2	2	1	0	0	X	7	6
PROCESS AND ROUTING	2	1	2	2	2	2	X	X	11	1
SHOP FLOOR CONTROL	1.5	1	2	2	2	2	X	X	10.5	2
CAPACITY PLANNING	1.5	1	2	0	1	0	X	X	5.5	8
STANDARD COSTING	2	1	1	2	2	2	0	X	10	3
MASTER SCHEDULING	0	1	1	0	1	2	X	X	5	9
ORDER ENTRY	0	1	2	2	2	2	X	X	9	4
FIELD SERVICE	2	X	0	2	2	2	X	X	8	5

0 = NO ACTIVITY, 1 = STUDY, 1.5 = BEING INSTALLED CURRENTLY, 2 = INSTALLED, X = NOT APPLICABLE

EXHIBIT II-6 (CONT.)

AVCO DIVISIONAL MANUFACTURING CONTROL STATUS (AS OF JUNE 16, 1981)

FUNCTION	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
MAINTENANCE CONTROL	1	1	1.5	0	1	0	0	X	4.5	10
TOOL AND GAUGE CONTROL	1.5	2	1	0	2	0	X	X	6.5	7
GROUP TECHNOLOGY	1	0	1	0	X	0	X	X	2	11
BATCH FACTORY DATA COLLECTION	2	2	2	2	X	0	0	X	8	5
ON-LINE FACTORY DATA COLLECTION	2	2	1	0	2	0	X	X	7	6
DIVISION TOTALS	23.5	17	23.5	20	24	18	0	0	126	-

0 = NO ACTIVITY, 1 = STUDY, 1.5 = BEING INSTALLED CURRENTLY, 2 = INSTALLED, X = NOT APPLICABLE

- Non-applicable functions, as determined by the divisions, are shown in the matrices of Exhibits II-3, 5, 6 by an X in the corresponding row and column.

- Exhibit II-7 shows the relationships of six of the divisions for comparative CAD/CAM/MCS functional activities.

  - For each of the CAD, CAM and MCS categories, the level of activity compared to the potential level of applicable functions for each division is shown as a percentage.

  - By example, Lycoming/Stratford has 20 applicable CAD functions, while Systems Division has 18.

  - The percentages shown in Exhibit II-7 are based upon only those functions that are applicable for each division.

  - Lycoming/Stratford's percentage for CAD status (79%) is based upon 20 applicable CAD functions for that division; Systems Division's percentage (64%) is based upon 18 CAD functions for that division.

- Exhibit II-8 graphically compares the six divisions (excluding Specialty Materials Division and Metalworking Laser Division) by functional level of CAD activity as a percentage of those that apply to each individual division.

  - Aerostructures Division leads all others with 94% of the applicable CAD functions currently active.

  - Electronics is very close in second position.

  - Systems Division utilizes CAD functions primarily for analytical computation rather than graphic display.

  - Williamsport and New Idea are currently evaluating their needs and available CAD systems.

EXHIBIT II-7

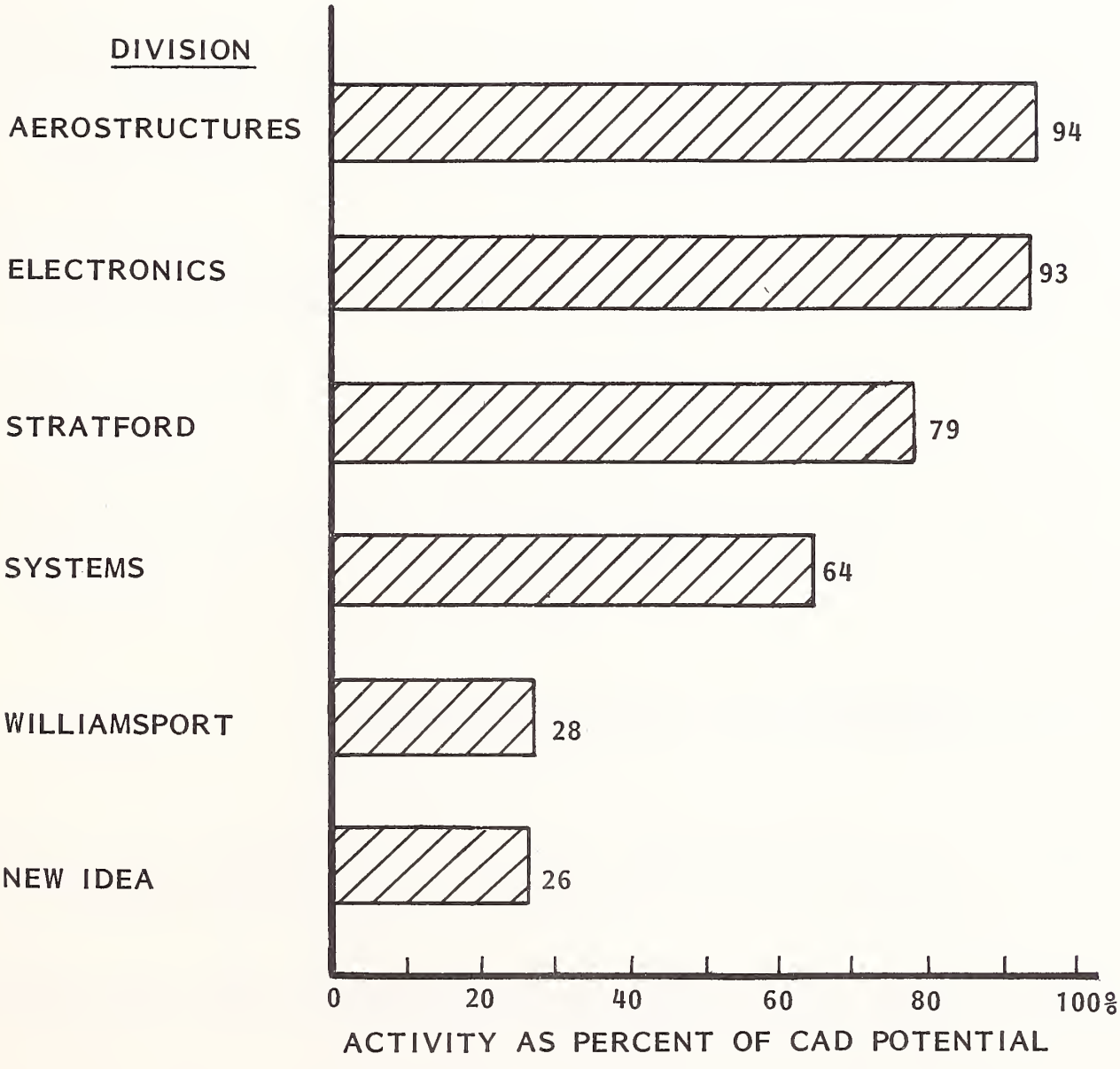
1981-1982 DIVISIONAL CAD/CAM/MCS
STATUS EVALUATION*

DIVISION	PERCENT POTENTIAL CAD	PERCENT POTENTIAL CAM	PERCENT POTENTIAL MCS	PERCENT TOTAL	RANK
ELECTRONICS	93	79	86	228	1
AEROSTRUCTURES	94	43	73	210	2
LYCOMING/STRATFORD	79	40	73	192	3
SYSTEMS	64	28	57	149	4
LYCOMING/WILLIAMSPORT	28	30	56	114	5
NEW IDEA	26	8	63	97	6
SPECIALTY MATERIALS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	-	-
METALWORKING LASERS	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE	-	-
AVCO AVERAGE LEVEL OF AUTOMATION PENETRATION	62%	34%	65%	CAD/CAM/MCS AVG. 54%	-

* MEASURED AS A PERCENT OF APPLICABLE ACTIVITIES FOR EACH FUNCTIONAL CATEGORY FOR EACH DIVISION

EXHIBIT II-8

1981 COMPARISON OF DIVISIONAL CAD
ACTIVITIES AS PERCENTAGE OF POTENTIAL



- Exhibit II-9 shows that for its own requirements, Electronics leads the other divisions in level of CAM development.

  - With the exception of New Idea, the other divisions are closely ranked.

- Exhibit II-10 shows that Electronics also leads the other divisions in level of applicable MCS development.

  - The high level of MCS penetration for all divisions compared to CAD and CAM is clear since all of the six divisions have greater than 50% activity compared to their applicable MCS functions.

- The bottom row of Exhibit II-7 shows that the average level of functional penetration is highest in the MCS category with a 65% level of activity.

  - The CAD penetration is close to MCS with a 62% average for all divisions.

  - CAM lags both MCS and CAD at 34% average. This is typical for most manufacturing organizations today.

D. DIVISIONAL CAD/CAM PERCEIVED NEEDS

- This section describes the current 1981-1982 perceived needs of the divisional management of each of the eight AVCO manufacturing divisions.

- Exhibit II-11 summarizes the levels of needs for 1981 to 1982 as perceived by the managers of the divisions.

  - At this stage of the study, the corporate Study Team has not evaluated or judged the suitability of these perceived needs.

EXHIBIT II-9

1981 COMPARISON OF DIVISIONAL CAM
ACTIVITIES AS PERCENTAGE OF POTENTIAL

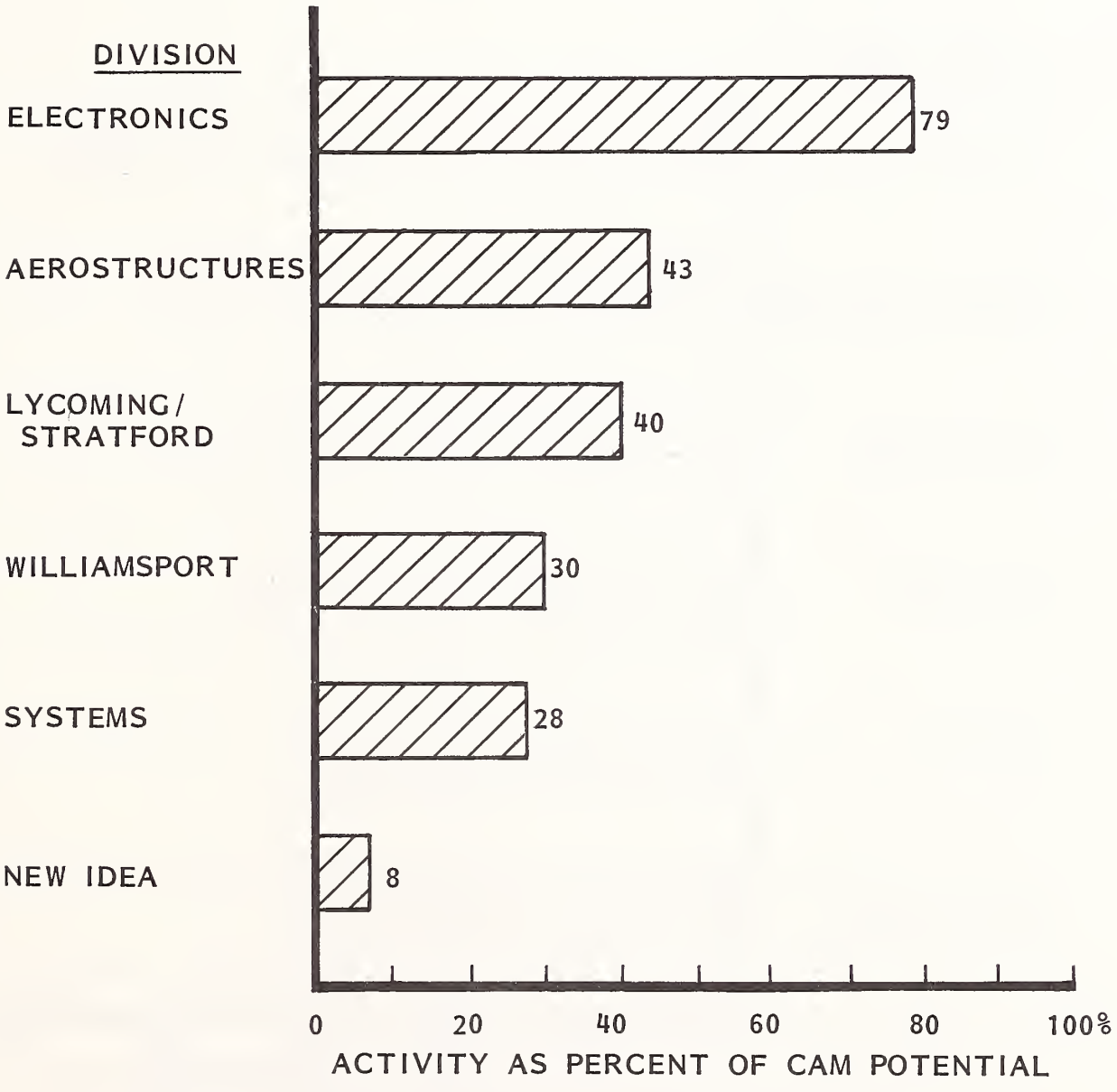


EXHIBIT II-10

1981 COMPARISON OF DIVISIONAL MANUFACTURING
CONTROL ACTIVITIES AS PERCENTAGE OF POTENTIAL

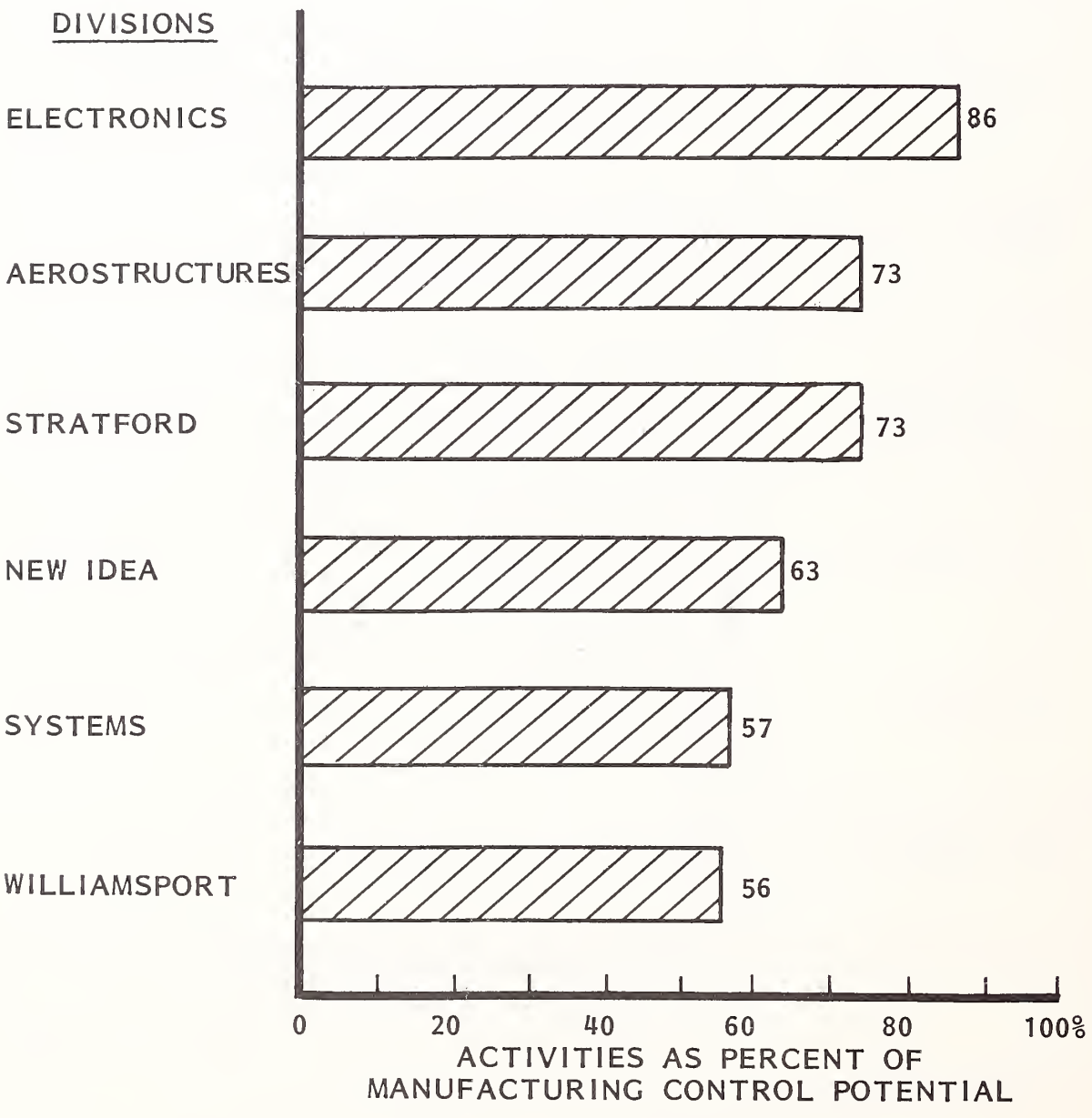


EXHIBIT II-11

1981-1982 DIVISIONAL CAD/CAM
PERCEIVED NEEDS EVALUATION*

DIVISION	CAD	CAM	MANU-FACTUR-ING CONTROL	DIVI-SIONAL TOTAL	DIVI-SIONAL RANK
LYCOMING/STRATFORD	55%	44%	85%	184%	3
AEROSTRUCTURES	47	67	86	200	2
NEW IDEA	74	38	71	183	4
SYSTEMS	80	35	96	211	1
LYCOMING/WILLIAMSPORT	54	35	11	100	6
ELECTRONICS	67	38	24	129	5
METALWORKING LASER	X	X	X	X	X
SPECIALTY MATERIALS	X	X	X	X	X
AVCO AVERAGE LEVEL OF PERCEIVED NEEDS	63%	43%	62%	-	-

* MEASURED AS A PERCENT OF APPLICABLE ACTIVITIES FOR EACH FUNCTIONAL CATEGORY
X = NOT MEASURED.

- The needs are ranked from a low score of one to a high score of three based upon:

  . Documented plans that were given to the study team during its initial visits to the divisions.

  . Presentations made by divisional personnel to the study team concerning CAD/CAM at the time of the initial site visits.

  . Discussions with the general manager of each division and his staff.

  . A review of each functional need at meetings between the Study Team and each divisional management.

- No attempt has been made to evaluate these needs against any criteria other than those listed above. This will be done later in this study.

- Longer term needs will also be evaluated later in the study.

- Only those functional needs that are applicable to each division are included in the scores shown in Exhibit II-11.

- Exhibit II-11 shows that the highest perceived needs in 1981 are for CAD systems.

  - Three divisions have installed systems that are being expanded.

  - Three divisions are actively investigating CAD systems.

- Manufacturing control systems rank next in order of divisional perceived needs.

- Most divisions already have some computer-assisted production control systems installed in their data processing departments.

- CAM systems rank lowest in order of perceived need.

  - To some extent, development of CAM will depend upon the installation of CAD systems.

I. CAD NEEDS

- The 1981-1982 CAD needs have been broken down into 21 separate functions that are identical to those listed in the CAD status analysis.

  - Exhibit II-12 shows the CAD functional needs as perceived by each division's management.

  - An X in the matrix indicates that the function does not apply to the division's type of business or near-term needs.

  - A one indicates low interest, while a score of three means very high interest.

- The weighted total index of needs for each division for all applicable functions is shown at the bottom of each divisional column in Exhibit II-12.

  - New Idea has the highest level of perceived CAD needs in the 1981-1982 time period.

  - Systems Division has the highest CAD needs percent of potential functions.

- There is a perceived need by at least one division in every CAD function except for automated flat pattern layout/nesting.

EXHIBIT II-12

DIVISIONAL PERCEIVED NEEDS: CAD(1981-1982)

NEED	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
SYSTEM EVALUATION	2	3	X	3	X	3	X	X	11	6
SYSTEM GROWTH	3	X	3	X	3	X	X	X	9	8
SYSTEM INSTALLATION	0	X	X	3	X	3	X	X	6	10
DESIGN-MECHANICAL	3	3	3	3	X	3	X	X	15	2
DESIGN-ELECTRICAL	0	3	X	2	1	X	X	X	6	10
DESIGN-ARCHITECTURAL	0	X	1	3	3	0	X	OPTICAL 3	10	7
DESIGN-TOOLING	1	2	0	3	X	2	X	X	8	9
DRAFTING	3	3	0	3	3	3	X	3	18	1
ANALYSIS-FEA	0	3	3	2	X	1	X	X	9	8
ANALYSIS-THERMAL	0	1	X	0	X	0	X	X	1	12
ANALYSIS-IC	0	2	X	0	2	0	X	X	4	11

0 = NO NEED, 1 = LOW NEED, 2 = MEDIUM NEED, 3 = HIGH NEED, X = NOT APPLICABLE

EXHIBIT II-12 (CONT.)

DIVISIONAL PERCEIVED NEEDS: CAD (1981-1982)

NEED	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
ANALYSIS-3D	3	3	0	3	X	1	X	3	13	4
ANALYSIS-OTHER	0	2	1	0	1	0	X	X	4	11
DESIGN RETRIEVAL	0	3	0	3	3	3	X	X	12	5
N/C TAPE PREP	3	2	0	3	2	2	X	X	12	4
TOOL OPTIMIZATION	3	1	2	3	0	0	X	X	9	8
AUTOMATIC LAYOUT/NESTING	X	X	X	X	X	X	X	X	0	13
ENGINEERING DATA BASE	3	3	2	3	1	3	X	X	15	2
MANUFACTURING PROCESS DOC.	3	1	3	2	X	2	X	X	11	6
MODELING	3	3	0	3	1	0	X	X	10	7
OTHER	3	3	3	0	2	3	X	X	14	3
DIVISIONAL TOTAL	33	41	21	42	22	29	0	9	197	1 -
INDEX	55	80	47	74	67	54	N/A	N/A	INDEX TOTAL	64

0 = NO NEED, 1 = LOW NEED, 2 = MEDIUM NEED, 3 = HIGH NEED, X = NOT APPLICABLE

- Exhibit II-13 summarizes the functional CAD needs for all divisions and ranks the top five areas.

  - Automated drafting is the highest overall CAD near-term perceived need.

2. CAM NEEDS

- Exhibit II-14 shows the levels of need for all divisions for CAM functions.

  - The weighted scores are logically derived in the same manner as are those shown in Exhibit II-12.

- Aerostructures has the highest CAM needs level of any of the AVCO divisions.

- Aerostructures also has the highest CAM Needs Index (69%).

  - All other divisions have comparable Needs Indices.

- Exhibit II-13 shows that computer numerical controlled machine tool needs have the highest CAM interest for all AVCO divisions together.

  - The other top CAM near-terms needs in order of importance are:

    . Automated inspection and test of completed products.

    . Numerical controlled machine tools.

    . Facilities management (energy control) systems.

    . Automated inspection and test of systems.

EXHIBIT II-13

1981 DIVISIONAL CAD/CAM

NEEDS SUMMARY BY FUNCTION

CAD	(ALL DIVISIONS) IN ORDER OF IMPORTANCE
1	DRAFTING
2	ENGINEERING DATA BASE GENERATION; MECHANICAL DESIGN
3	N/C TAPE PREPARATION; ANALYSIS-3D
CAM	**(ALL DIVISIONS) IN ORDER OF IMPORTANCE**
1	CNC MACHINE TOOLING
2	AUTOMATED INSPECTION AND TEST OF MECHANICAL PARTS
3	DIRECT NUMERICAL CONTROL
4	FACILITIES MANAGEMENT; SYSTEMS INSPECTION AND TEST
MANU-FACTURING CONTROL	**(ALL DIVISIONS) IN ORDER OF IMPORTANCE**
1	PURCHASING
2	MATERIAL CONTROL; CAPACITY PLANNING; MASTER SCHEDULING

EXHIBIT II-14

DIVISIONAL PERCEIVED NEEDS: CAM (1981-1982)

NEED	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
N/C MACHINE TOOLS	1	3	3	3	X	3	X	X	13	3
CNC MACHINE TOOLS	3	3	3	3	X	3	X	X	15	1
DNC MACHINE TOOLS	3	X	3	0	X	1	X	X	7	8
FMC	3	X	1	1	X	3	X	X	8	7
AUTOMATED STORAGE/RETRIEVAL	3	0	1	3	X	0	X	X	7	8
AUTOMATED WAREHOUSE	0	0	X	0	X	0	X	X	0	14
TOOLING AND GAUGE SYSTEM	3	0	1	1	X	3	X	X	8	7
GUIDED VEHICLE SYSTEM	0	0	1	0	X	0	X	X	1	13
ROBOT MATERIAL HANDLING	0	0	X	1	X	0	X	X	1	13
OTHER MATERIAL HANDLING	0	0	0	0	X	0	X	X	0	14

0 = NO NEED, 1 = LOW NEED, 2 = MEDIUM NEED, 3 = HIGH NEED, X = NOT APPLICABLE

EXHIBIT II-14 (CONT.)

DIVISIONAL PERCEIVED NEEDS CAM (1981-1982)

NEED	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
ASSEMBLY-ROBOT	0	0	3	0	0	0	X	X	3	11
ASSEMBLY-OTHER	0	2	0	0	0	0	X	X	2	12
INSPECTION AND TEST ELECTRONIC	0	3	3	2	2	0	X	X	10	6
INSPECTION AND TEST- MECHANICAL	3	3	3	0	2	3	X	X	14	2
INSPECTION AND TEST-SYSTEMS	3	3	1	0	2	3	X	X	12	4
INSPECTION AND TEST-PROCESS	0	1	3	0	X	0	1	X	5	10
ROBOT-WELDING	3	0	X	3	X	0	X	X	6	9

0 = NO NEED, 1 = LOW NEED, 2 = MEDIUM NEED, 3 = HIGH NEED, X = NOT APPLICABLE

EXHIBIT II-14 (CONT.)

DIVISIONAL PERCEIVED NEEDS: CAM (1981-1982)

NEED	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
ROBOT-PAINTING	0	0	3	3	X	0	X	X	6	9
ROBOT-OTHER	0	0	3	0	0	0	X	X	3	11
FACILITIES MANAGEMENT	X	1	3	3	2	2	0	X	11	5
TOTAL	25	19	35	23	8	21	1	0	132	-
NEEDS INDEX	44	35	69	38	38	35	N/A	TOTAL CORPORATE INDEX		43

0 = NO NEED, 1 = LOW NEED, 2 = MEDIUM NEED, 3 = HIGH NEED, X = NOT APPLICABLE

3. MANUFACTURING CONTROL PERCEIVED NEEDS

- Manufacturing control systems perceived needs have a level that is equal to that of CAD and greater than the level for CAM. Exhibit II-15 shows the divisional needs.
  - Systems Division has the highest level of needs, while Williamsport has the lowest.
  - Systems also has the highest Needs Index (96%), while Aerostructures and Lycoming/Stratford are a close 2nd and 3rd respectively.
- Exhibit II-13 shows that for all AVCO divisions together, the primary needs for manufacturing control are:
  - Purchasing.
  - Material control.
  - Capacity planning.
  - Master scheduling.

4. COMPARISONS OF CAD/CAM NEEDS

- The perceived needs for all the CAD/CAM functions have been compared across all AVCO divisions.
  - Exhibit II-16 lists the top thirteen functions in order of relative priorities.
    - Automated drawing generation has the highest level of need of any function at AVCO.

EXHIBIT II-15

DIVISIONAL PERCEIVED NEEDS: MANUFACTURING CONTROL (1981-1982)

NEED	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
BILL OF MATERIAL	3	3	3	3	0	0	X	X	12	3
MATERIAL CONTROL	3	3	3	3	1	0	X	X	13	2
MATERIALS RE-QUIREMENTS PL.	3	3	3	2	1	0	X	X	12	3
PURCHASING	3	3	3	2	3	0	X	X	14	1
PROCESS AND ROUTING	3	3	3	3	0	0	X	X	12	3
SHOP FLOOR CONTROL	3	3	3	3	0	0	X	X	12	3
CAPACITY PLANNING	3	3	3	3	1	0	X	X	13	2
STANDARD COSTING	0	3	2	2	0	0	X	X	7	6
MASTER SCHEDULING	3	3	3	3	1	0	X	X	13	2
ORDER ENTRY	3	3	2	0	0	0	X	X	8	5
FIELD SERVICE	3	X	X	0	1	3	X	X	7	6

0 = NO NEED, 1 = LOW NEED, 2 = MEDIUM NEED, 3 = HIGH NEED, X = NOT APPLICABLE

EXHIBIT II-15 (CONT.)

DIVISIONAL PERCEIVED NEEDS: MANUFACTURING CONTROL (1981-1982)

NEED	LY-COMING STRAT-FORD	SYSTEMS	AERO-STRUC-TURES	NEW IDEA	ELEC-TRONICS	LY-COMING WILLIAMS-PORT	SPEC. MA-TERIALS	METAL-WORK LASER	SCORE/RANK	
MAINTENANCE CONTROL	3	3	3	2	1	0	X	X	12	3
TOOL AND GAUGE CONTROL	3	3	2	2	1	0	X	X	11	4
GROUP TECHNOLOGY	3	1	0	3	X	0	X	X	7	6
BATCH FACTORY DATA COLLECTION	0	3	X	0	X	2	X	X	5	7
ON-LINE FACTORY DATA COLLECTION	2	3	3	3	0	X	X	X	11	4
DIVISIONAL TOTAL	41	43	36	34	10	5	0	0	169	-
NEEDS INDEX	85	96	86	71	24	11	X	TOTAL INDEX		63

0 = NO NEED, 1 = LOW NEED, 2 = MEDIUM NEED, 3 = HIGH NEED, X = NOT APPLICABLE

EXHIBIT II-16

AVCO DIVISIONAL PERCEIVED NEEDS

(1981-1982)

PRIORITY	FUNCTION	PERCEIVED NEEDS SCORE
1	AUTOMATED DRAWING GENERATION	18
2	MECHANICAL DESIGN,	15
	CNC MACHINE TOOLING,	15
	ENGINEERING DATA BASE GENERATION	15
3	PURCHASING,	14
	DESIGN-MECHANICAL,	14
	CAD - OTHER	14
4	ANALYSIS - 3D,	13
	N/C TAPE PREPARATION,	13
	N/C MACHINE TOOLS,	13
	MATERIAL CONTROL,	13
	CAPACITY PLANNING,	13
	MASTER SCHEDULING	13

- In August 1980, CAM-I, an industry CAD/CAM association, conducted a survey of U. S. industries with regard to the relative levels of interest in CAD/CAM functions. The results of this survey are shown in Exhibit II-17.

  - For the composite of all industries, the specific CAM functions appear to have little correlation to the 1981-1982 CAD/CAM interests at AVCO.

  - The differences are accounted for by the fact that the CAM-I survey did not include CAD functions. It also includes industries in which AVCO does not participate.

- Exhibit II-18 shows a previous CAM-I survey that was completed in 1975.

  - In this 1975 list of CAM-I, CAM interests more closely resemble AVCO's current interests.

E. INITIAL ASSESSMENT FOR NEAR-TERM CAD/CAM DEVELOPMENT

- An initial assessment for CAD/CAM development within the 1981-1982 timeframe has been made by the Corporate Study Team. Exhibit II-19 lists the divisions and gives a numerical rating of the potential for near-term development.

  - The range of scores is from zero (none, or not applicable) to five for the highest rating.

  - The Systems Division has the highest AVCO ranking.

    . Systems has high CAD analytical capabilities and high MCS potential.

EXHIBIT II-17

U.S. INDUSTRY SURVEY

UNDERTAKING	CAM-I SURVEY COMPOSITE RANK	AIRCRAFT	AUTO-MOTIVE/ EARTH MOVING	ELEC-TRICAL/ ELEC-TRONICS	SOFTWARE SYSTEMS AND SERVICES	MACHINERY	OTHER*
ROBOTICS	1ST	1ST	5TH	5TH	1ST	4TH	1ST
ASSEMBLY PLANNING AND CONTROL	2ND	4TH	2ND	1ST	2ND	1ST	3RD
QUALITY CONTROL	3RD	2ND	8TH	2ND	4TH	3RD	2ND
PRODUCIBILITY	4TH	3RD	1ST	3RD	5TH	2ND	6TH
COMPUTER AIDED TESTING	5TH	7TH	7TH	4TH	8TH	9TH	4TH
TOOL CONTROL	6TH	8TH	3RD	8TH	11TH	5TH	5TH
MATERIAL HANDLING	7TH	5TH	6TH	9TH	6TH	11TH	7TH
FACILITIES PLANNING	8TH	12TH	4TH	10TH	7TH	7TH	9TH
INVENTORY MANAGEMENT	9TH	6TH	9TH	6TH	3RD	6TH	11TH
MAINTENANCE	10TH	9TH	11TH	12TH	14TH	8TH	13TH
AUDIT AND COST CONTROL	11TH	11TH	10TH	13TH	10TH	12TH	10TH
COMPUTER AIDED ENTERPRISE STRUCTURE	12TH	12TH	12TH	11TH	9TH	10TH	8TH
ENERGY PLANNING	13TH	13TH	13TH	14TH	13TH	14TH	12TH
PURCHASING	14TH	14TH	14TH	7TH	12TH	13TH	14TH

*INCLUDES: PRODUCT RESEARCH AND DEVELOPMENT, CONSULTING AND MANAGEMENT SERVICE, ENERGY SERVICE TOOLS/EQUIPMENT, NUCLEAR, DEPARTMENT OF DEFENSE CONTRACTOR, AND OTHER MISCELLANEOUS ITEMS.

NOTE: OF THE 200 TOTAL RESPONSES, 19 SELECTED MORE THAN ONE OF THE ABOVE INDUSTRY TYPES, 129 DID NOT RESPOND TO EACH ALTERNATIVE, AND 27 DID NOT RESPOND TO THIS QUESTION AT ALL.

EXHIBIT II-18

MANUFACTURING INTERESTS
(1975)

PRIORITY	FUNCTION
1	MANUFACTURING DATA BASE DESIGN
2	SCHEDULING
3	COMPUTERIZED NUMERICAL CONTROL (CNC)
4	GROUP TECHNOLOGY
5	INTERACTIVE GRAPHICS
6	ADAPTIVE CONTROL
7	DIRECT NUMERICAL CONTROL (DNC)
8	IN-PROCESS INSPECTION
9	COMPUTERIZED MATERIALS HANDLING
10	N/C VERIFICATION SYSTEM
11	AUTOMATED DRAWING GENERATION
12	DIE SINKING
13	COMPUTER CONTROLLED ASSEMBLY LINE OPERATIONS
14	COMPUTER CONTROLLED TRANSFER LINE

SOURCE: CAM-I INDUSTRY SURVEY

EXHIBIT II-19

ASSESSMENT FOR CAD/CAM NEAR-TERM DEVELOPMENT

DIVISION	CAD	CAM	MANU-FACTURING CONTROL	OVERALL TOTAL	RANK
AEROSTRUCTURES	3	3	3	9	4
NEW IDEA	3	2	5	10	3
LYCOMING/WILLIAMSPORT	3	2	2	7	6
LYCOMING/STRATFORD	4	2	2	8	5
ELECTRONICS	5	3	3	11	2
SYSTEMS	5	3	5	13	1
TOTALS	23	15	20	58	-

- Electronics ranks second, primarily because of strengths in the CAD area as well as above average CAM and MCS capabilities.

- Two divisions - Metalworking Laser and Specialty Materials - are not currently performing significant piece parts manufacturing operations. Therefore, their CAD/CAM near-term potential for development has not been included in this assessment.

- The areas for greatest near-term success for all the AVCO manufacturing divisions as a group are in CAD and Manufacturing Control Systems.

  - CAM is viewed with less optimism because:

    . CAM success usually follows on and results in part from CAD implementation.

    . CAM implementation is expensive since usually old equipment has to be removed as well as new equipment installed.

    . CAD and Manufacturing Control Systems are relatively less expensive to install.

III AEROSTRUCTURES DIVISION

III AEROSTRUCTURES DIVISION

A. CAD/CAM STATUS

- The current level of CAD/CAM activity at the Aerostructures Division (AD) was investigated by the corporate study team.

  - The level is measured against all the potential CAD/CAM functions as defined in the Appendix and as shown in Exhibit III-1.

  - These functions are interrelated, as was explained during the initial presentation that was made to AD during the study team's visit to Nashville on February 16, 1981.

- Exhibit III-2 shows the areas and levels of existing activity related to CAD/CAM and automated manufacturing control systems. These activities are derived from four primary sources:

  - A review of each of the matrices by division management at a meeting with the CAD/CAM corporate study team on June 4, 1981.

  - Documented plans that were given to the study team during its initial visit.

  - Presentations made by AD management.

EXHIBIT III-1

CAD/CAM INTEGRATION

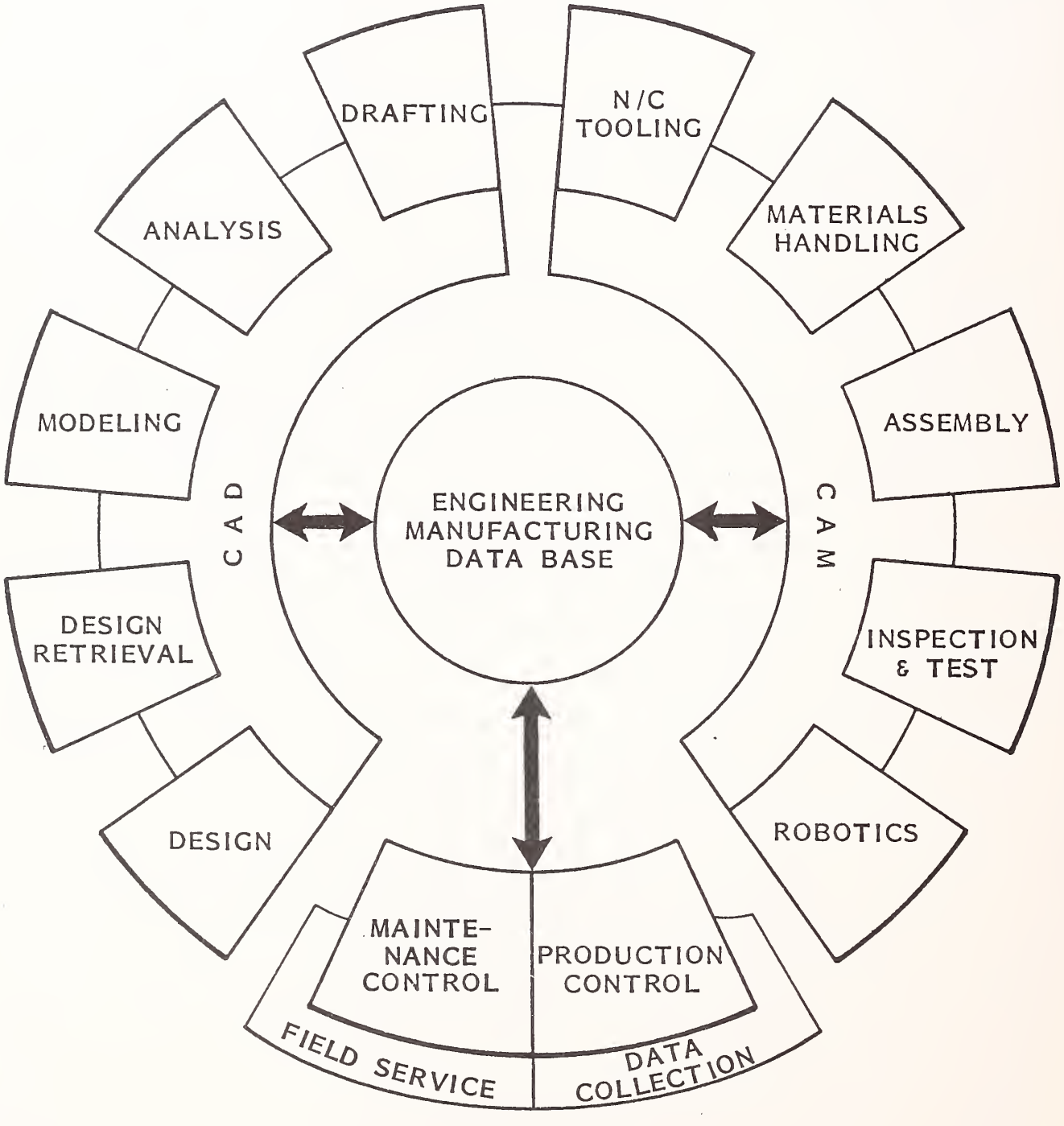


EXHIBIT III-2

AEROSTRUCTURES DIVISION:

CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	GERBER	N/C TOOLS	(1) 125 / 12 (2)	BILL OF MATERIAL	IN-STALLED
SYSTEM GROWTH	CONTIN-UING	CNC	30 / 2 YRS.		
SYSTEM INSTALLATION	COM-PLETED	DNC	STUDY / X	MATERIAL CONTROL	IN-STALLED
		FMC	STUDY / X		
DESIGN MECHANICAL	IN-STALLED			MATERIALS REQ. PLANNING	STUDY
DESIGN ELECTRICAL	X	MATERIALS HANDLING	X		
DESIGN STRUCTURAL	IN-STALLED			PURCHASING	IN-STALLED
DESIGN TOOLING	IN-STALLED	- WAREHOUSE	*		
		- TOOLING AND GAUGE	*	PROCESS AND ROUTING	IN-STALLED
DRAFTING	PROGRAM CONTROLS CHART	- GUIDED VEHICLE SYSTEM	*		
		- ROBOT	*	SHOP FLOOR CONTROL	IN-STALLED
ANALYSIS FEA	IN-STALLED	- OTHER	*		
ANALYSIS THERMAL	X			CAPACITY PLANNING	IN-STALLED
ANALYSIS IC	X	ASSEMBLY	X		
ANALYSIS 3D	IN-STALLED	- ROBOT	STUDY	STANDARD COSTING	STUDY
ANALYSIS OTHER	IN-STALLED	- OTHER	IN-STALLED		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT

(1) NUMBER INSTALLED

(2) AVERAGE AGE

X = DOES NOT APPLY TO THIS DIVISION

EXHIBIT III-2 (Cont.)

AEROSTRUCTURES DIVISION: CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	IN-STALLED	INSPECTION AND TEST		MASTER SCHEDULING	STUDY
		- ELECTRONIC	STUDY		
N/C CAPABILITIES		- MECHANICAL	IN-STALLED	ORDER ENTRY	IN-STALLED
- TAPE PREP	IN-STALLED	- SYSTEMS	*		
- TOOL OPTIM.	IN-STALLED	- PROCESS	STUDY	FIELD SERVICE	*
- FLAT PATTERN LAYOUT/NESTING	IN-STALLED				
ENGINEERING DATA BASE	IN-STALLED			MAINTENANCE CONTROL	BEING IN-STALLED
		ROBOTICS			
MANUFACTURING PROCESS DOC.	STUDY	- WELDING	*	TOOL AND GAUGE CONTROL	STUDY
		- PAINTING	EVALU-ATING		
MODELING	IN-STALLED	- OTHER	EVALU-ATING	GROUP TECHNOLOGY	STUDY
OTHER	STUDY			FACTORY DATA COLLECTION	
				- BATCH I/O	IN-STALLED
				- ON-LINE	STUDY
		FACILITIES MANAGEMENT	IN-STALLED		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT

- Notes prepared by members of the study team which are based upon individual and group discussions with AD personnel.

I. CAD STATUS

- AD has installed a Gerber IDS-3 turnkey CAD system. (Cost: $857,000)
  - It consists of seven Tektronix monochromatic workstations.
  - There is also a Gerber DMS.
  - There is a Gerber flatbed plotter system.
  - There is a communications link to the IBM 370/158 mainframe.
  - The plotter is used for machine tool cutter path generation and part geometry.
- Gerber software is the standard IDS with numerically controlled (N/C) programming and tool path optimization capabilities.
  - This is particularly important since Boeing, a major customer, supplies part geometries on tape in the Gerber format.
  - There are twelve N/C parts programmers, six of whom are job shoppers.
- System growth is continuing because the need for N/C program optimization continues to build, and management believes that the system pays for itself in improved production capacity through optimized N/C tool control programs.
  - Current evaluations consist of investigating the use of a Versatec plotter for shop floor planning and control and upgrading the Gerber to utilize IDS 80 software and hardware.

- It is believed that large economies can potentially be obtained from this application.

- Tool design is a major activity for AD.
  - The very large wing assembly jigs and fixtures represent a complex design problem.
  - The 3-D capability of the Gerber IDS system is critical to the success of this function.
- The Gerber system has been in place for two years. This vendor was chosen for the following reasons:
  - Boeing uses the Gerber for N/C applications; AD can easily interface with its most important customer.
  - The IDS uses a two and one-half axis mode for tool path generation.
  - The turnkey vendor approach eliminated conflicts between hardware and software vendors.
  - The large flatbed plotter interface was required.
  - Gerber was willing to supply the graphics source code.
- CAD engineers demonstrated tool cutter path generation using an AD part for the Study Team.
- Most of the training for the operations of the CAD system is done in-house.

- There is an acute shortage of CAD operators in the Nashville area.

- Existing N/C programmers had backgrounds in machine tooling operations and in manual N/C programming. They became proficient in programming on the CAD system in three to nine months.

- Major strengths of the Gerber system are seen as:

  - Potential for CAD/CAM integration.

  - Locally controlled data management and systems security.

- Major limitations are seen as:

  - Limited file capacity.

  - Slow interactive workstation response time.

- No analysis functions are installed on the Gerber system.

2. CAM STATUS

- Aerostructures has a vast manufacturing facility of about two million square feet of space. The complete tour of the facility took two full half days. The range of machine tools, in both size and age, is extensive.

  - Metal cutting machines that handle parts up to 100 feet long and 14 feet wide are installed.

  - Two of the latest Japanese CNC milling machines worth over $1 million each are installed and are being debugged by the vendor's on-site team.

- The average N/C tool age is about 12 years.

- There is extensive use of CNC machine tools.

  - The average age of these is about two years.

  - Allen-Bradley controllers are used to a large extent, but the division has been unhappy with the support received from this vendor lately.

  - Studies are underway to find a more responsive vendor.

- A major problem is the shortage of skilled operators for the sophisticated tools. Another is finding maintenance personnel for these machines.

  - One estimate is that with present equipment, metal is being cut only about 30% of the time. The remaining time is spent in set-up, maintenance and scheduling.

  - The replacement of existing tooling is more difficult than simply adding new tooling. However some old machine refurbishment is possible.

  - There is a strong labor union in the plant, but there has been no opposition to automation.

  - AD has one robot from Cincinnati Millicron.

    . This will be evaluated in the lab and its capabilities will be proven before it is introduced to the plant floor.

    . Current applications for robots are expected to be for sealing, deburring, spray painting and coating of parts and assemblies.

    . A Thermwood N/C router is being installed.

- There is no materials handling automation in place.
  - Assembly operations are done manually, many times in huge fixtures.
- Inspection and test is a major function at AD.
  - Three levels of inspection are required:
    . In-house (AD).
    . Customer (Boeing, Lockheed, etc.).
    . Governmental agencies (FAA, NASA, Air Force, etc.).
  - The data collected for these inspection buy-offs is immense. However, no CAM systems have been installed for inspection and test or the associated data handling.
- A batch I/O factory data collection system is installed.
- A computer-based facilities (energy) management system is installed.

3. MANUFACTURING CONTROL STATUS

- Aerostructures has an IBM 370/158MP for DP functions. Production control, inventory control and purchasing are DP responsibilities.
  - An upgraded Materials Resource Planning system is currently being evaluated.
  - COPICS, Comserv and MAS-E (Martin-Marietta) are the contenders.
  - No decision has been reached yet.

B. CAD/CAM: PERCEIVED NEEDS

- Exhibit III-3 lists the CAD/CAM needs as seen by AD. The needs are current (1981 and 1982).

  - The high rating indicates that documentation exists which explains the basis of the need and the general objectives for satisfying it during the calendar years 1981-1982.

  - A medium rating indicates that this need was discussed at presentations to the study team during its plant tour or during informal discussions.

  - Where there is an asterisk opposite the function, either there was no mention of the need by AD management, or the need was not expected to fall within the 1982 timeframe.

- On a weighted basis, AD ranks fifth out of six divisions for total level of CAD/CAM needs, as perceived by divisional management, as shown in Exhibit II-8.

  - Manufacturing control system (MCS) functions are the most needed with 86% of all applicable MCS needs.

  - CAM needs represent 67% of the total applicable CAM functions.

  - CAD needs account for 47% of the CAD total functions that are applicable to the Aerostructures division. Exhibit III-4 shows these relationships.

1. CAD: PERCEIVED NEEDS

- A prioritized planning list of major CAD/CAM systems was given to the study team during its visit to AD.

EXHIBIT III-3

AEROSTRUCTURES DIVISION:

PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	X	N/C TOOLS	HIGH	BILL OF MATERIAL	HIGH
SYSTEM GROWTH	HIGH	CNC	HIGH		
SYSTEM INSTALLATION	X	DNC	HIGH	MATERIAL CONTROL	HIGH
DESIGN		FMC	LOW		
- MECHANICAL	HIGH			MATERIALS REQ. PLANNING	HIGH
- ELECTRICAL	X	MATERIALS HANDLING			
- STRUCTURAL	LOW	- STORAGE AND RETRIEVAL	LOW	PURCHASING	HIGH
- TOOLING	*	- WAREHOUSE	X		
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE SYSTEMS	LOW	PROCESS AND ROUTING	HIGH
- DRAFTING	*	- GUIDED VEHICLE SYSTEMS	LOW		
ANALYSIS		- ROBOT	X	SHOP FLOOR CONTROL	HIGH
- FEA	HIGH	- OTHER	*		
- THERMAL	X			CAPACITY PLANNING	HIGH
- IC	X	ASSEMBLY			
- THREE D	*	- ROBOT	HIGH	STANDARD COSTING	MEDIUM
- OTHER	LOW	- OTHER	*		

*NO 1981 PERCEIVED NEEDS
X = NOT APPLICABLE TO THIS DIVISION

EXHIBIT III-3 (Cont.)

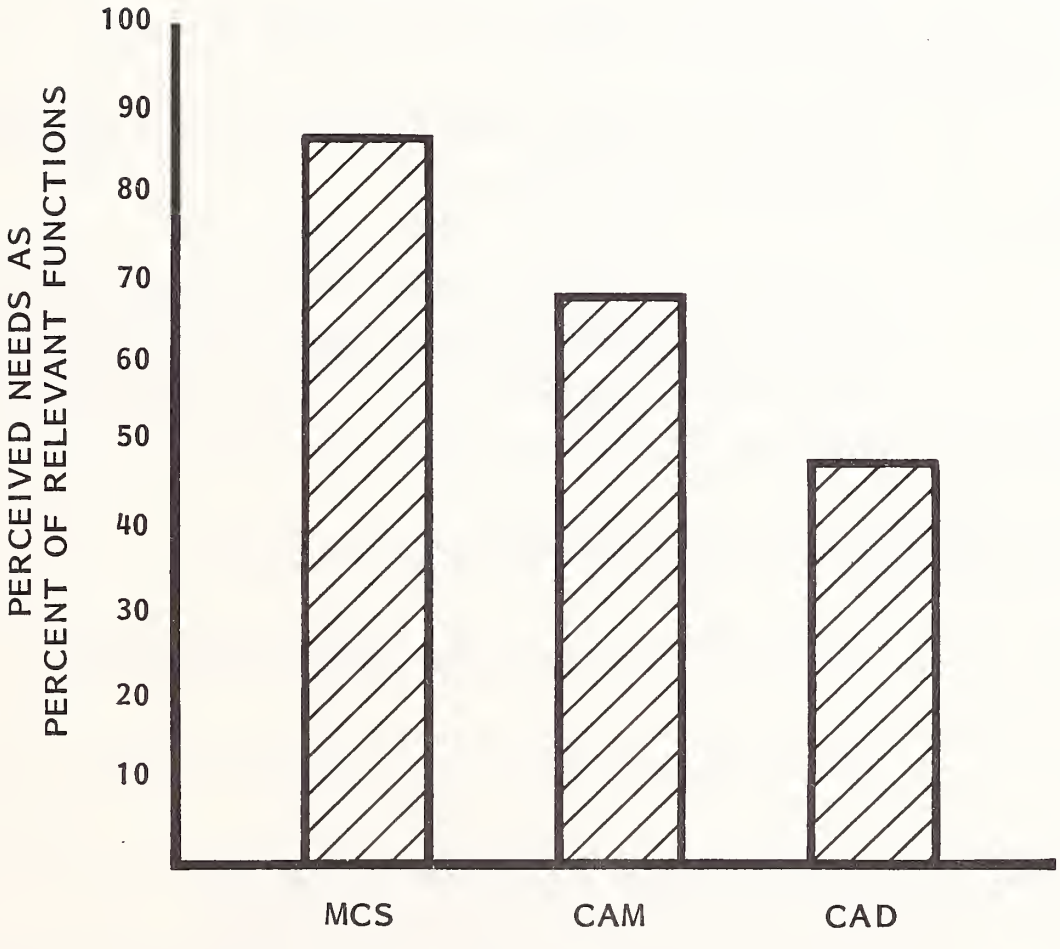
AEROSTRUCTURES DIVISION: PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	*	INSPECTION AND TEST		MASTER SCHEDULING	HIGH
		- ELECTRONIC	HIGH		
N/C CAPABILITIES		- MECHANICAL	HIGH	ORDER ENTRY	MEDIUM
- TAPE PREP	*	- SYSTEMS	LOW		
- TOOL OPTIM.	MEDIUM	- PROCESS	HIGH	FIELD SERVICE	X
ENGINEERING DATA BASE	MEDIUM			MAINTENANCE CONTROL	HIGH
		ROBOTICS			
MANUFACTURING PROCESS DOC.	HIGH	- WELDING	X	TOOL AND GAUGE CONTROL	MEDIUM
		- PAINTING	HIGH		
MODELING	*	- OTHER	CUTTING HIGH	GROUP TECHNOLOGY	*
OTHER	GRAPHIC DISPLAYS			FACTORY DATA COLLECTION	
	GRAPHIC COMMUNI-CATIONS			- BATCH I/O	X
	STAN-DARDS			- ON-LINE	HIGH
		FACILITIES MANAGEMENT	HIGH		

*NO 1981 PERCEIVED NEEDS
X = NOT APPLICABLE TO THIS DIVISION

EXHIBIT III-4

PERCEIVED CAD/CAM NEEDS
AEROSTRUCTURES DIVISION: 1981/1982



- First on the list is the need to establish a single N/C and geometric data base for both engineering and manufacturing use.

  . These data are planned to be stored on the mainframe, but will be capable of being accessed by the CAD system, as well as by various CAM systems.

- The second highest priority is to implement an updated version of the original Gerber software with the new IDS-80.

- Other CAD priorities include:

  . Graphics used to display business statistics.

  . The use of the IGES standard graphic communication protocol to communicate with customers.

  . A method for comparing an original N/C program with a revised one to highlight only the differences. This would apply to both the machine programs and the cutter tool path verification changes.

- Additional CAD needs of high priority include:

  . The enhancement of mechanical design capabilities.

  . Finite element analysis.

  . Manufacturing process documentation.

  . Other engineering analysis, such as vibration and wire harness and routing applications.

- Altogether, 21 areas of CAD applications needs were identified, as shown in Exhibit III-3.

  - Compared to all the other AVCO divisions, the number of CAD needs at AD are perceived by management to be less than those of any other division, as shown in Exhibit III-4.

    . This is because only limited product design is done at AD.

2. CAM: PERCEIVED NEEDS

- The list of CAM needs was second only to that of the Lycoming/Stratford Division of all AVCO divisions. On the prioritized list of planned major systems, the following CAM functions are shown:

  - Automated sheet metal system.

  - N/C, DNC, and CNC machine tool equipment.

  - Distributed post-processing of N/C by each machine tool.

  - Automated inspection and test of completed assemblies.

  - N/C tube bending integrated with CAD.

- Other CAM requirements that were stressed were:

  - The need to plan ahead of future manufacturing demands so that the capabilities will be on hand when they are needed.

    . Currently there are very long lead times (greater than 12 months) for machine tool delivery.

. This situation may well intensify as industry begins to spend ever increasing amounts for modern tools in order to meet international competition for productivity and quality.

. One manager estimated the AD will need to spend $23 million on new tooling alone during the next five years in order to keep up with demand and competitive pressures.

- Robots for riveting and painting.

- Facilities management automation system.

3. MANUFACTURING CONTROL: PERCEIVED NEEDS

- AD management expressed a high need for new manufacturing control systems. This is under study now.

- A need was expressed for a maintenance control system that would provide equipment usage, discrepancies, failure records and preventive maintenance schedules based upon actual history.

  - With the current high level of very old and very new machines, the cost of a system is thought to be of especially high value for cost savings to AD.

- An on-line factory data collection system is needed.

C. INITIAL ASSESSMENT FOR CAD/CAM DEVELOPMENT

- The corporate study team has made an initial assessment for CAD/CAM development at each of the AVCO manufacturing divisions.

- These judgements are based upon:

  . The current status of the divisions.

  . The level of management commitment.

  . The extent of need for CAD/CAM for the division's competitive position.

  . The ability of existing division personnel to accomplish the CAD/CAM objectives.

- Also considered were:

  . Anticipated growth of the division.

  . Age of existing facilities and equipment.

  . Impact of CAD/CAM capabilities on obtaining future business.

  . The potential value of CAD/CAM investment upon the division's current product mix.

I. CAD ASSESSMENT

- The CAD system at AD is judged to be about average.

  - It is not as well developed as Stratford's CAD system; at this stage it is more advanced than the Electronics Division's system which has recently been installed.

- As mentioned earlier in this report, there is a severe shortage of skilled CAD technicians in the Nashville area.

- The experienced savings from CAD have been positive, and the equipment is relatively new (two years) with high growth potential.

- It is expected that CAD will have a high level of impact upon the division, probably more so than on any AVCO division because of the nature of the products and the outlook for new business at Nashville.

- In summary, the near-term estimate for CAD success is judged to be average.

2. CAM ASSESSMENT

- The current competitive position is judged to be average. Considering that the division has significant growth potential and the nature of the industry and the products of the division, CAM will be important to the growth of the division.

  - Exhibit III-5 shows the CAM capability.

  - The in-house capabilities to implement the very large amount of expected CAM potential are currently limited, but average for the industry.

  - There is no skilled labor pool nearby upon which to draw.

- The average age of the N/C equipment is 12 years.

  - Non-N/C equipment average age is much older.

  - Materials handling automation and computer-based test and inspection are also major opportunities.

- The Study Team believes that the potential for improving productivity is the highest of all AVCO manufacturing divisions. The magnitude of the task and the other factors in the overall assessment for CAM development lead us to the conclusion that the chances for near-term CAM development are average.

EXHIBIT III-5

AEROSTRUCTURES DIVISION:
STUDY TEAM ASSESSMENT OF CAD/CAM DEVELOPMENT
IN 1981-1982 RELATIVE TO OTHER AVCO DIVISIONS

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	AVERAGE	AVERAGE	AVERAGE
MANAGEMENT COMMITMENT	AVERAGE	AVERAGE	AVERAGE
COMPETITIVE POSITION*	BELOW AVERAGE	AVERAGE	BELOW AVERAGE
IN-HOUSE CAPABILITIES	AVERAGE	AVERAGE	AVERAGE
ANTICIPATED GROWTH	HIGH	HIGH	AVERAGE
EQUIPMENT AGE	2 YEARS	12 YEARS	BELOW AVERAGE
IMPACT	HIGH	HIGH	HIGH
POTENTIAL FOR NEAR TERM DEVELOPMENT	AVERAGE	AVERAGE	AVERAGE

*RELATIVE TO EXTERNAL COMPETITION

3. MANUFACTURING CONTROL ASSESSMENT

- Considering the size and complexity of the Aerostructures manufacturing operations, the level of manufacturing control is average.

- The competitive position is below average.

- It is not clear that the Aerostructures Division has sufficient computing capacity to be able to cope with the long-term MCS plans and needs.

- The potential for major profitability improvement through upgrading the manufacturing control systems seems high; the overall estimate for near-term success is judged to be above average.

D. CONCLUSIONS AND RECOMMENDATIONS

- As shown in Exhibit III-6, the current status of CAD at Aerostructures is above average, compared to other divisions, while CAM and MCS are judged to be average.

  - The need for CAM investment is one of the highest for any AVCO manufacturing division.

  - The near-term potential for CAM success is judged to be average in comparision to the aerospace industry in which Aerostructures is competing. The ever higher cost and shortage of skilled labor may force a substantial investment that is likely to be needed.

- Aerostructures is in a difficult situation because of this heavy capital investment needed to maintain its competitive posture long-term.

- Several recommendations can be made at this early stage. They include:

EXHIBIT III-6

AEROSTRUCTURES DIVISION:

OVERALL CONCLUSIONS BY STUDY TEAM

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	ABOVE AVERAGE	AVERAGE	BELOW AVERAGE
PERCEIVED NEEDS	BELOW AVERAGE	AVERAGE	AVERAGE
POTENTIAL FOR NEAR TERM	AVERAGE	AVERAGE	AVERAGE

- A pursuit of government funding to modernize the facility.

  . Millions are being spent by the Air Force ICAM program to upgrade production facilities like the one at Nashville. Examples include TECHMOD, MANTECH, etc.

  . Phase One of the TECHMOD program has been completed at AD.

  . AVCO is participating in these programs.

  . An example is that Northrup has provided funds to support the assembly wedge of the ICAM project to AD.

- Requests to participate in the Vought sheet metal fab wedge of ICAM have been received at Aerostructures.

- A difficult problem is that the facilities were built during World War II. Not only does new equipment have to be installed, but the old equipment has to be removed.

IV NEW IDEA DIVISION

IV NEW IDEA DIVISION

A. CAD/CAM STATUS

- The current level of CAD/CAM activity at the New Idea Division was investigated by the Corporate Study Team.
  - Exhibit IV-1 shows this level measured against all the potential CAD/CAM functions defined in Chapter II, the Executive Summary.
  - Data were collected during a full day visit to Coldwater by the study team on February 20, 1981.
  - After the visit, additional data were obtained by telephone discussions with management at New Idea.
  - Final revisions were made as a result of a second meeting between management and the study team on June 3, 1981.
- Exhibit IV-2 shows the areas and levels of existing activity of CAD/CAM and automated manufacturing control systems.
- These activities are derived from four primary sources.
  - Documented plans that were given to the study team during its initial visit.

EXHIBIT IV-1

CAD/CAM INTEGRATION

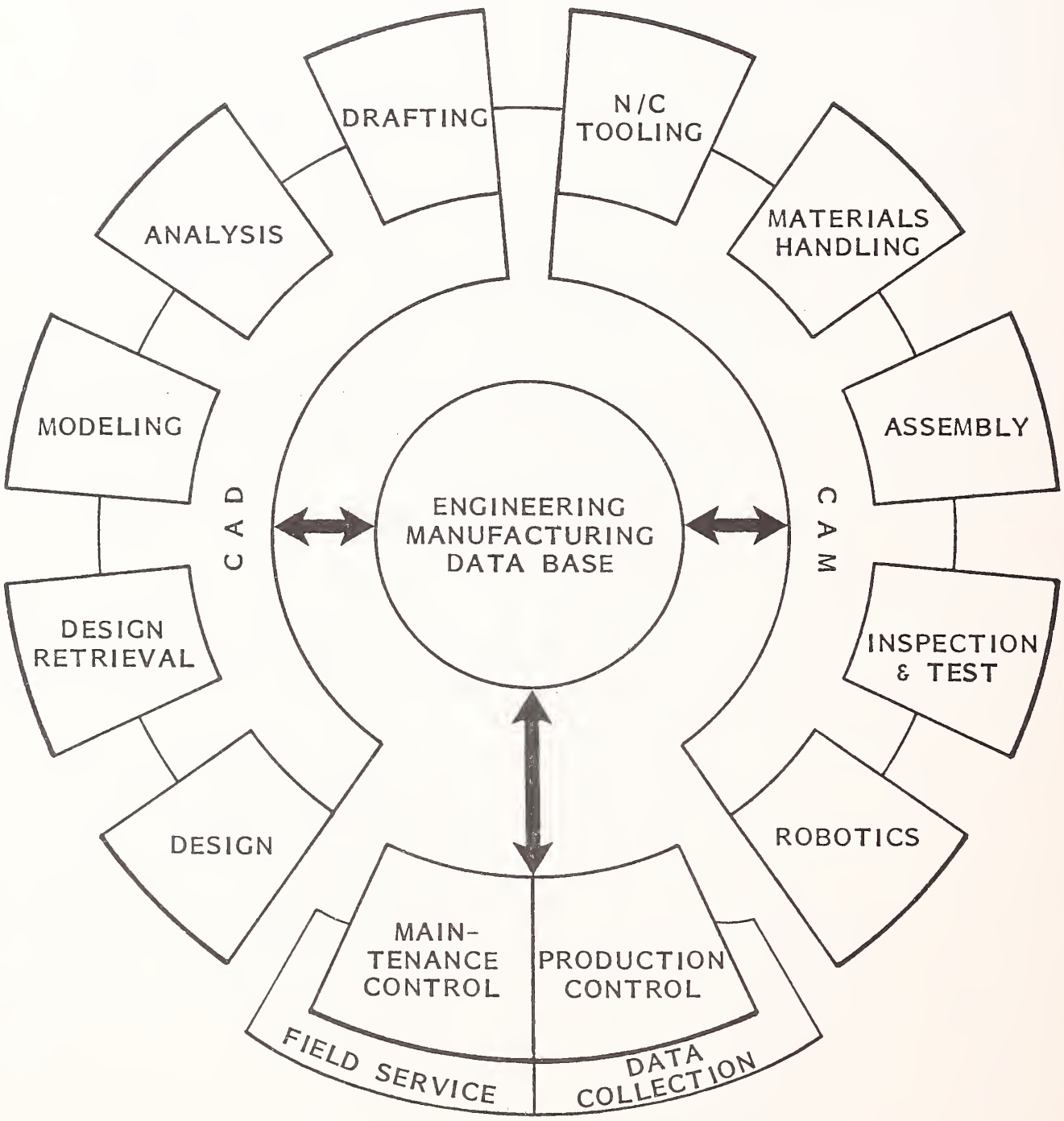


EXHIBIT IV-2

NEW IDEA DIVISION:

CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING - CONTROL	
SYSTEM SELECTION	STUDY	N/C TOOLS	(1) 5 / 2 (2)	BILL OF MATERIAL	IN-STALLED
SYSTEM GROWTH	*	CNC	* / X		
SYSTEM INSTALLATION	*	DNC	* / X	MATERIAL CONTROL	IN-STALLED
		FMC	* / X		
DESIGN MECHANICAL	*			MATERIALS REQ. PLANNING	IN-STALLED
DESIGN ELECTRICAL	*	MATERIALS HANDLING			
DESIGN STRUCTURAL (A)	TIME SHARE TO SDRC	- STORAGE AND RETRIEVAL	*	PURCHASING	IN-STALLED
DESIGN TOOLING	*	- WAREHOUSE	*		
		- TOOLING AND GAUGE	*	PROCESS AND ROUTING	IN-STALLED
DRAFTING	*	- GUIDED VEHICLE SYSTEM	*		
		- ROBOT	*	SHOP FLOOR CONTROL	IN-STALLED
ANALYSIS FEA	WITH SDRC AND CDC	- OTHER	*		
ANALYSIS THERMAL	*			CAPACITY PLANNING	*
ANALYSIS IC	*	ASSEMBLY			
ANALYSIS 3D	*	- ROBOT	*	STANDARD COSTING	IN-STALLED
ANALYSIS OTHER	*	- OTHER	*		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT, BUT LIKELY IN FUTURE
(1) NUMBER INSTALLED
(2) AVERAGE AGE
(A) AS IT PERTAINS TO MACHINE STRUCTURES

EXHIBIT IV-2 (CONT.)

NEW IDEA DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	*	INSPECTION AND TEST		MASTER SCHEDULING	*
		- ELECTRONIC	*		
N/C CAPABILITIES		- MECHANICAL	*	ORDER ENTRY	IN-STALLED
- TAPE PREP	STUDY	- SYSTEMS	*		
- TOOL OPTIM.	*	- PROCESS	*	FIELD SERVICE	IN-STALLED
- FLAT PATTERN LAYOUT/NESTING	STUDY	CAM INTEGRATION	*		
ENGINEERING DATA BASE	PART NO. ID			MAINTENANCE CONTROL	*
		ROBOTICS			
MANUFACTURING PROCESS DOC.	*	- WELDING	STUDY	TOOL AND GAUGE CONTROL	*
		- PAINTING	*		
MODELING	WITH SDRC AND CDC	- OTHER	*	GROUP TECHNOLOGY	*
OTHER	*			FACTORY DATA COLLECTION	
				- BATCH I/O	IN-STALLED
				- ON-LINE	*
		FACILITIES MANAGEMENT	*		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT, BUT LIKELY IN FUTURE

- Presentations made by New Idea management.

- Notes prepared by members of the study team which are based upon individual and group discussions with New Idea personnel during two separate visits to Coldwater by the Study Team.

- Trip reports that were prepared by Norm Bernstein.

1. CAD STATUS

- Exhibit IV-2 shows that there is no CAD system in use at New Idea.

  - Studies are underway to establish the divisional CAD requirements and the various means of satisfying these requirements.

- Current considerations include:

  - Timeshare remote CAD graphics services.

  - Purchase or lease of CAD software for use on upgraded in-house mainframe.

  - Remote terminal to Lycoming/Stratford Unigraphics system.

  - Purchase of a turnkey standalone CAD system from a major system supplier.

- At the time of the initial visit, the CAD requirements definition, the priorities and the system evaluation methodology had not been entirely established.

  - It was agreed that the various CAD system alternatives could be evaluated only after the requirement analysis was complete.

  - New Idea is studying these needs.

- Great interest in assistance from other AVCO divisions and/or other sources such as consultants was expressed by the management.

- Bob Engle stated that he was "completely open" to any help he could get.

- Computer involvement in New Idea product engineering at present includes the use of an on-line terminal to the IBM 370/125 for a parts description terminal display.

  - This information is reportedly accessed "continuously" by New Idea engineers.

  - Mr. Ron Ronayne, Director of Engineering, stated that they "couldn't live without it," a strong endorsement for the value of an on-line engineering data base.

- A TI Silent 700 and a portable TI 765 printing terminal are used in a timesharing mode to SDRC for engineering design structural analysis.

2. CAM STATUS

- New Idea has recently installed five N/C machine tools.

  - These have Allen-Bradley controls.

  - Good support is obtained from the local Allen-Bradley maintenance depot.

  - It is believed that the relatively close proximity of Coldwater to Allen-Bradley headquarters in Milwaukee will contribute towards continual good support in the future.

- For these reasons New Idea intends to standardize on Allen-Bradley N/C controls where feasible for future N/C automation equipment.

- New Idea's experience with its limited N/C automation has been very positive.

  - This investment in CAM has paid for itself through productivity gains and also through better quality products because of improved parts fabrication consistency.

- The study team had a chance to ask one N/C machine operater how he felt about N/C automation.

  - This is critical since the factory has a strong United Auto Workers union shop.

  - The machine operator said he really liked this automation because the work was more challenging and he could produce better quality work with it.

    . He had bid for the chance to become an N/C operator.

    . He would not want to have to return to the old manual machine tool.

- This machine operator's reaction to CAM is quite similar to that found in most U.S. factories.

  - Even the strongest unions support greater levels of automation.

  - They clearly realize that unless their productivity matches that of their competitors', worldwide, they may lose their jobs.

  - The workers are also proud and eager to work with the best equipment that is available. CAM contributes to morale and good labor relations.

- It was observed that the average age of all New Idea machines is about 20 years, with some equipment much older than that.

- At New Idea there are no CNC, DNC machines or flexible machining centers (FMC).

  - There is a combined materials handling and sheet metal stamping machine that has saved on raw materials costs and in materials handling labor.

  - Currently the N/C machines are used for producing parts that are long-run items.

  - There is a shortage of N/C programming capability that prevents using the N/C tools for short-run parts. Division management stated the need for 500 more N/C tapes.

- The study team did not find any automated assembly, inspection and test or robotic equipment.

  - Robots are being considered for welding and painting applications.

- The plant is very old, but it is clean and appears to be safe and orderly.

- A DPI/NCR, Model 1405 factory data collection system (FDC) is installed.

  - There are 27 DPI Model 205 input stations.

  - These are batch card input terminals without output capability.

  - The terminals are used for both factory floor and attendance reporting.

3. MANUFACTURING CONTROL STATUS

- The BOM, process, tooling and cost data are maintained in the IBM 370/125.
  - These files are accessed by CRT terminals (IBM 3277 and others).
  - COM is used for the history of fabricated parts.
- Daily production routing packets are generated for each part and assembly to be produced.
  - Data from the factory data collection system are processed during the night shift on the mainframe for the next day's shop floor control needs.
  - Work in process inventory, finished products and service parts inventories are generated by the 370/125.
  - Purchase orders are prepared by using an on-line terminal.
- A Sycor data entry system is used to store and control the service parts inventory at each of four regional centers.
  - This batch teleprocessing system records and transmits to the 370/125 all daily business transactions.
  - There are no automated factory equipment maintenance control systems or tool and gauge control systems within the plant.
- The existing 370/125 with 256K of main memory is at full capacity.
  - Additional functions will necessitate upgrading to a more powerful CPU.

- A tentative decision has been made to add an IBM 4341 front-end to the existing CPU.

- Only limited amounts of the CAD/CAM capabilities of the other AVCO manufacturing divisions are known in Coldwater.

  - New Idea management expressed keen interest in sharing ideas and solutions to problems with other AVCO divisions.

B. CAD/CAM: PERCEIVED NEEDS

- Exhibit IV-3 lists the CAD/CAM needs as perceived by New Idea.

  - The needs are current (1981 and 1982).

  - The high rating indicates that documentation exists which explains the basis of the need and the general objectives for satisfying it during the calendar year 1981.

  - A medium rating indicates that this need was discussed at presentations to the study team, but may not be contained in a documented plan.

  - The low rating indicates that this need was informally mentioned to one or more members of the study team during its plant tours or during informal discussions.

  - Where there is an asterisk opposite the function, either there was no mention of the need by New Idea management, or the need was not perceived to fall within the 1981-1982 timeframe.

- On a weighted basis, New Idea ranked third out of six divisions on total CAD/CAM needs.

EXHIBIT IV-3

NEW IDEA DIVISION: PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	HIGH	N/C TOOLS	HIGH	BILL OF MATERIAL	ON-LINE HIGH
SYSTEM GROWTH	X	CNC	HIGH		
SYSTEM INSTALLATION	HIGH	DNC	*	MATERIAL CONTROL	HIGH
		FMC	LOW		
DESIGN MECHANICAL	HIGH			MATERIALS REQ. PLANNING	MEDIUM
DESIGN ELECTRICAL	MEDIUM	MATERIALS HANDLING			
DESIGN ARCHITECTURAL	HIGH	- STORAGE AND RETRIEVAL	HIGH	PURCHASING	MEDIUM
DESIGN TOOLING	MEDIUM	- WAREHOUSE	*		
		- TOOLING AND GAUGE	LOW	PROCESS AND ROUTING	HIGH
DRAFTING	HIGH	- GUIDED VEHICLE SYSTEM	*		
		- ROBOT	LOW	SHOP FLOOR CONTROL	HIGH
ANALYSIS FEA	MEDIUM	- OTHER	*		
ANALYSIS THERMAL	*			CAPACITY PLANNING	HIGH
ANALYSIS IC	*	ASSEMBLY			
ANALYSIS 3D	HIGH	- ROBOT	*	STANDARD COSTING	MEDIUM
ANALYSIS OTHER	*	- OTHER	*		

*NO 1981 PERCEIVED NEEDS
X = DOES NOT APPLY TO THIS DIVISION

EXHIBIT IV-3 (CONT.)

NEW IDEA DIVISION:

PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	HIGH	INSPECTION AND TEST		MASTER SCHEDULING	HIGH
		- ELECTRONIC	MEDIUM		
N/C CAPABILITIES		- MECHANICAL	*	ORDER ENTRY	*
- TAPE PREP	HIGH	- SYSTEMS	*		
- TOOL OPTIM.	HIGH	- PROCESS	*	FIELD SERVICE	*
- PATTERN LAYOUT	X				
ENGINEERING DATA BASE	HIGH			MAINTENANCE CONTROL	MEDIUM
		ROBOTICS			
MANUFACTURING PROCESS DOC.	MEDIUM	- WELDING	HIGH	TOOL AND GAUGE CONTROL	MEDIUM
		- PAINTING	HIGH		
MODELING	HIGH	- OTHER	*	GROUP TECHNOLOGY	HIGH
OTHER	*			FACTORY DATA COLLECTION	
				- BATCH I/O	*
				- ON-LINE	HIGH
		FACILITIES MANAGEMENT	HIGH		

*NO 1981 PERCEIVED NEEDS

- Exhibit IV-4 shows that CAD functions are the most needed, with 74% of the total perceived needs, as measured as a percent of applicable functions for the division.

- Manufacturing control systems represent a need level of 71% of all applicable functions.

- CAM accounts for 38%.

- The high level of need expressed for CAD is what would be expected since New Idea is serious about improving its design capabilities.

  - CAD is the logical starting point.

- The need for manufacturing control reflects the mix of products and the seasonal nature of New Idea's production activities.

  - Where new models are introduced annually and volume builds and diminishes, manufacturing control is essential to keep order in the midst of constant change.

1. CAD: PERCEIVED NEEDS

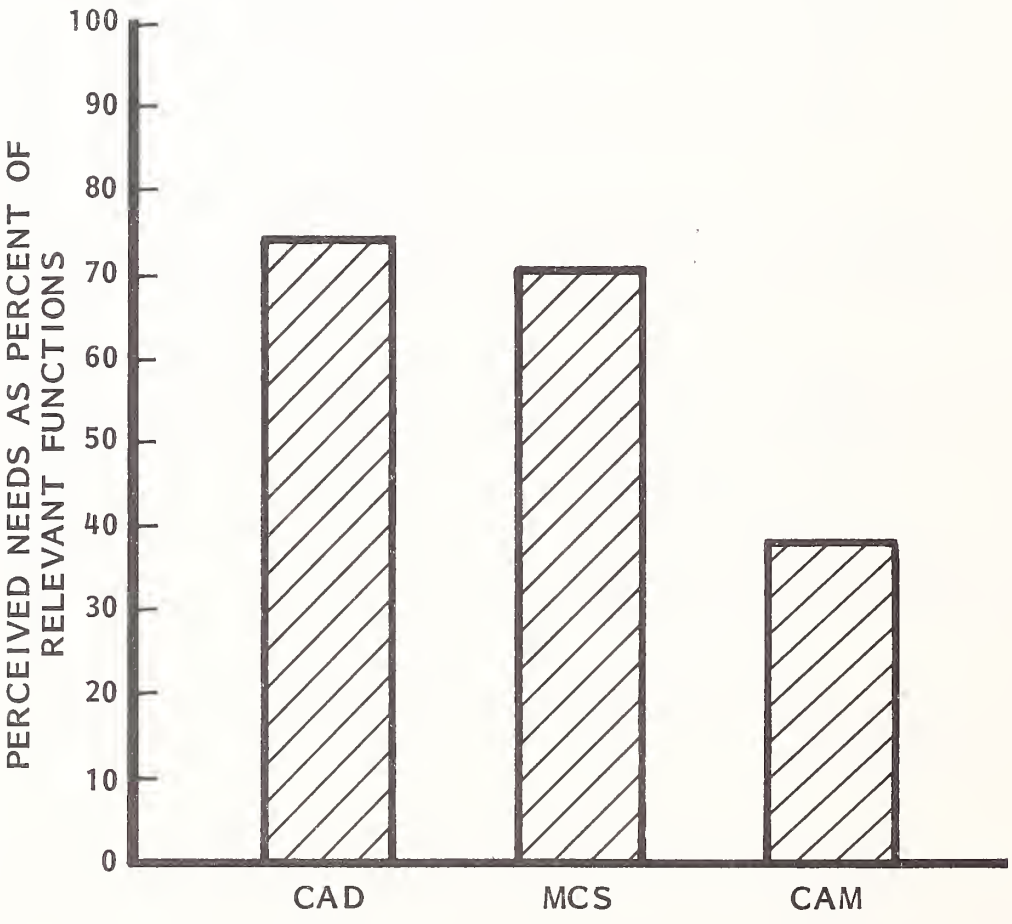
- The immediate need to select a CAD system was discussed in Section A.1 of this chapter.

  - The use of the CAD system for automated drawing production, 3-D analysis, N/C tape preparation and mechanical parts design were the most wanted features in the near term.

  - The use of CAD to replace the dependency upon the single N/C programmer and to generate tapes for immediate short-run use on the five existing N/C machines is clearly the highest priority of all of the CAD needs.

EXHIBIT IV-4

PERCEIVED CAD/CAM NEEDS
NEW IDEA DIVISION: 1981/1982



- The use of CAD to replace the dependence upon the N/C tape preparation equipment and for mechanical parts design were stressed.

- Other CAD needs in order of perceived importance are:

  - Finite element analysis.

  - Manufacturing process documentation for fabrication/assembly.

  - Part design data retrieval system.

  - Manufacturing process documentation for prototype development.

2. CAM: PERCEIVED NEEDS

- The greatest CAM need is for replacement of old metal-cutting machine tools with CNC equipment.

- Welding is a major assembly function at New Idea.

  - The use of robots for welding operations is thought to offer a high potential for rapid payback while improving product quality.

- In addition, robots are being considered for spray painting applications.

  - There have been some field complaints about the quality of New Idea paint on finished products.

- Integration of CAD and CAM through common data base development is of average interest.

- Other CAM functions have a low priority for 1981.

- Those that were mentioned to the study team were automated storage and retrieval systems, and tool and gauge control.

- A flexible machining center, such as at Stratford and Williamsport, are of interest, but at a low level of need.

- It is not suprising that CAM is of less immediate interest to New Idea than CAD because CAM is more costly to implement.

  - CAM will be dependent to some extent upon the implementation of CAD.

  - Furthermore, CAD appears to offer more immediate productivity leverage than does CAM for New Idea.

3. MANUFACTURING CONTROL: PERCEIVED NEEDS

- Upgrading the existing DP computer capability so that more effective software systems may be added for plant operations control is of high interest to New Idea.

  - In particular, on-line access to the computer for bill of material, production process and routing and material control are currently planned.

- Of lesser importance, the following functions are also of interest:

  - Master scheduling.

  - Capacity planning.

  - Group technology.

  - On-line factory data collection.

C. INITIAL ASSESSMENT FOR CAD/CAM

- The corporate study team made an initial assessment of the probabilities for development in CAD/CAM at each of the AVCO manufacturing divisions.

  - These judgements are based upon:

    . The current status of the divisions.

    . The level of management commitment.

    . The extent of need for CAD/CAM for the division's competitive position.

    . The ability of existing division personnel to accomplish the CAD/CAM objective.

  - Also considered were:

    . Anticipated growth of the division.

    . Age of existing facilities and equipment.

    . Impact of CAD/CAM capabilities on obtaining future business.

    . The potential value of CAD/CAM investment upon the division's current product mix.

1. CAD ASSESSMENT

- Exhibit IV-5 shows that New Idea is starting from the beginning in CAD since no systems yet exist.

EXHIBIT IV-5

NEW IDEA DIVISION:
STUDY TEAM ASSESSMENT OF CAD/CAM DEVELOPMENT
IN 1981-1982 RELATIVE TO OTHER AVCO DIVISIONS

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	LOW	LOW	ABOVE AVERAGE
MANAGEMENT COMMITMENT	HIGH	HIGH	HIGH
COMPETITIVE POSITION*	BELOW AVERAGE	LOW	AVERAGE
IN-HOUSE CAPABILITIES	LOW	BELOW AVERAGE	AVERAGE
ANTICIPATED GROWTH	AVERAGE	LOW	LOW
EQUIPMENT AGE	N/A	HIGH	HIGH
IMPACT	HIGH	HIGH	AVERAGE
POTENTIAL FOR NEAR-TERM DEVELOPMENT	AVERAGE	BELOW AVERAGE	HIGH

*RELATIVE TO EXTERNAL COMPETITION

- However, management and the entire engineering organization has a high level of commitment and interest in developing a CAD system.

- The farm equipment industry is advanced in the use of CAD, especially the industry leaders such as International Harvester and Deere.

- There is an urgent need for New Idea to catch up, and for this reason the impact of CAD will be high.

- For example, a CAD system that will permit automation of N/C tape development will allow greater utilization of the existing N/C equipment.

- Other major benefits will be derived from CAD, such as:

  - Design analysis.

  - Engineering data base.

  - Increased design productivity for mechanical parts and fixturing.

- An obstacle to CAD success is that New Idea is at a low point in its business cycle.

  - The in-house capabilities are low at present since the engineering department has had no experience with procuring and using CAD.

- In summary, the study team believes that New Idea will need to invest in training and equipment, but that managemant commitment will make CAD implementation possible.

2. CAM ASSESSMENT

- The current low level of CAM equipment and the old age of existing equipment means that when more modern equipment is installed, it will have a high impact upon the division's profits.

- However, management and the entire engineering organization has a high level of commitment and interest in developing a CAD system.

- The farm equipment industry is advanced in the use of CAD, especially the industry leaders such as International Harvester and Deere.

- There is an urgent need for New Idea to catch up, and for this reason the impact of CAD will be high.

- For example, a CAD system that will permit automation of N/C tape development will allow greater utilization of the existing N/C equipment.

- Other major benefits will be derived from CAD, such as:

  - Design analysis.

  - Engineering data base.

  - Increased design productivity for mechanical parts and fixturing.

- An obstacle to CAD success is that New Idea is at a low point in its business cycle.

  - The in-house capabilities are low at present since the engineering department has had no experience with procuring and using CAD.

- In summary, the study team believes that New Idea will need to invest in training and equipment, but that managemant commitment will make CAD implementation possible.

2. CAM ASSESSMENT

- The current low level of CAM equipment and the old age of existing equipment means that when more modern equipment is installed, it will have a high impact upon the division's profits.

- The study team sees a high probability for development in this area.

D. CONCLUSIONS AND RECOMMENDATIONS

- As shown in Exhibit IV-6, the current status of CAD/CAM at New Idea is low except for manufacturing control.

  - The needs are high for both CAD and MCS, but less urgent for the latter because the current systems are above average in this area.

  - CAD should have a higher priority than CAM in the near term, but the reverse will be true once the basic CAD activity is operational.

- The potential for CAD development in the near term is judged to be average with significant potential benefits within the next five years.

- CAM potential is judged to be below average in the near term because of the high cost of making significant initial CAM installations.

- With the acquisition of a more powerful CPU, the chances for success in manufacturing control appear to be high compared to the rest of the industry.

- The Study Team recommends that a CAD system be evaluated as soon as possible, and that strong consideration should be given to upgrading the IBM 370/125.

  - To the extent economically feasible, additional CNC tools should replace existing equipment.

  - Robots for welding and painting should be considered for CAM.

EXHIBIT IV-6

NEW IDEA DIVISION:

OVERALL CONCLUSIONS BY STUDY TEAM

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	LOW	LOW	ABOVE AVERAGE
PERCEIVED NEEDS	HIGH	HIGH	BELOW AVERAGE
POTENTIAL FOR NEAR TERM	AVERAGE	BELOW AVERAGE	HIGH

- Automation of materials handling may be deferred, but on-line factory data collection terminals need to be added to and/or substituted for existing batch oriented terminals so that real-time manufacturing controls can be implemented.

V LYCOMING/WILLIAMSPORT DIVISION

V LYCOMING/WILLIAMSPORT DIVISION

A. CAD/CAM STATUS

- The current level of CAD/CAM activity at the Lycoming/Williamsport Division (LW) was investigated by the corporate study team.
  - The level is measured against all the potential CAD/CAM functions as defined in Chapter II, the Executive Summary.
  - Exhibit V-1 details these functions.
  - These functions are interrelated, as was explained during the initial presentation made to LW during the study team's visit to Williamsport on March 6, 1981.
- Exhibit V-2 shows the areas and levels of existing activity related to CAD, CAM and automated manufacturing control systems.
  - These activities are derived from four primary sources:
    - Documented plans that were given to the study team during its initial visit.
    - Presentations made by LW management.

EXHIBIT V-1

CAD/CAM INTEGRATION

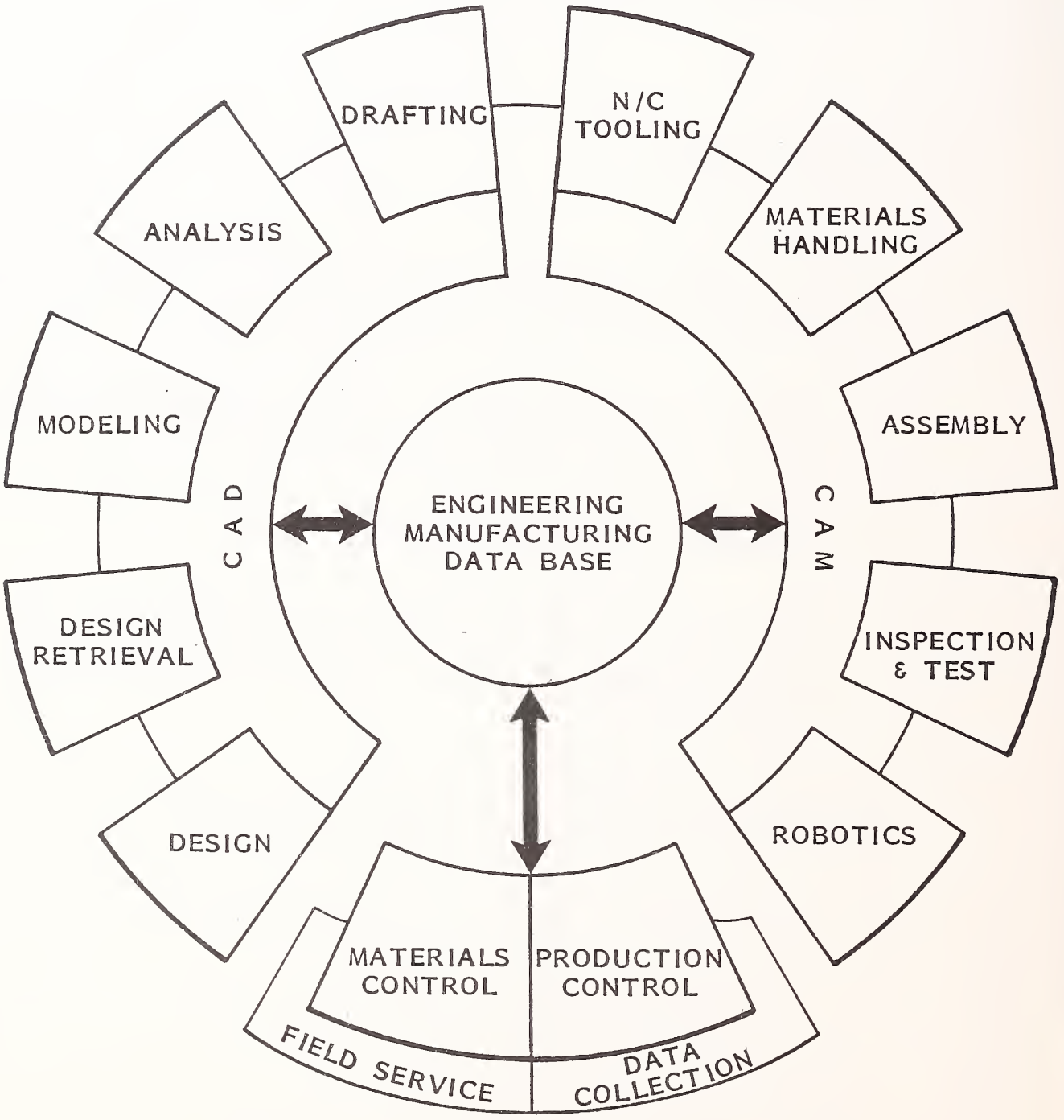


EXHIBIT V-2

LYCOMING/WILLIAMSPORT DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	STUDY	N/C TOOLS	(1) 65 / 7 YRS. (2)	BILL OF MATERIAL	IN-STALLED
SYSTEM GROWTH	X	CNC	8 / 2 YRS.		
SYSTEM INSTALLATION	X	DNC	* / X	MATERIAL CONTROL	IN-STALLED
DESIGN		FMC	1 / 2 YRS.		
- MECHANICAL	STUDY			MATERIALS REQ. PLANNING	IN-STALLED
- ELECTRICAL	X	MATERIALS HANDLING			
- ARCHITECTURAL	X	- STORAGE AND RETRIEVAL	*	PURCHASING	*
- TOOLING	STUDY	- WAREHOUSE	*		
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE	*	PROCESS AND ROUTING	IN-STALLED
- DRAFTING	STUDY	- GUIDED VEHICLE SYSTEMS	*		
ANALYSIS		- ROBOT	*	SHOP FLOOR CONTROL	IN-STALLED
- FEA	*	- OTHER	*		
- THERMAL	*			CAPACITY PLANNING	*
- IC	*	ASSEMBLY			
- THREE D	*	- ROBOT	*	STANDARD COSTING	IN-STALLED
- OTHER	INSTALLED	- OTHER	*		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT

(1) NUMBER INSTALLED

(2) AVERAGE AGE

X = DOES NOT APPLY TO THIS DIVISION

EXHIBIT V-2 (CONT.)

LYCOMING/WILLIAMSPORT DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	*	INSPECTION AND TEST		MASTER SCHEDULING	IN-STALLED
		- ELECTRONIC	*		
N/C CAPABILITIES		- MECHANICAL	*	ORDER ENTRY	IN-STALLED
- TAPE PREP	*	- SYSTEMS	IN-STALLED		
- TOOL OPTIM.	*	- PROCESS	STUDY	FIELD SERVICE	IN-STALLED
ENGINEERING DATA BASE	*			MAINTENANCE CONTROL	*
		ROBOTICS			
MANUFACTURING PROCESS DOC.	*	- WELDING	STUDY	TOOL AND GAUGE CONTROL	*
		- PAINTING	STUDY		
MODELING	IN-STALLED	- OTHER	STUDY	GROUP TECHNOLOGY	*
OTHER	COMM. STUDY			FACTORY DATA COLLECTION	
				- BATCH I/O	*
				- ON-LINE	*
		FACILITIES MANAGEMENT	*		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT

. Notes prepared by members of the study team based upon individual and group discussions with LW personnel.

. A review of the divisional status and needs by the Study Team and management during a second visit to Williamsport on May 20, 1981.

1. CAD STATUS

- There is no installed CAD system at LW.
  - The division is currently studying various alternative ways to satisfy its requirements.
  - Current considerations include:
    . Timeshare to remote graphics service bureau.
    . Purchase or lease CAD software for use on an upgraded in-house mainframe computer.
    . Access via remote terminal the Lycoming/Stratford Unigraphics system.
    . Purchase a turnkey, standalone CAD system from a major system supplier.
- At the time of the study team's visit, the requirements had been documented.
  - An individual has been assigned the responsibility for evaluating the alternatives.
  - He is also to be trained at Stratford in order to become familiar with the characteristics of a CAD system.

- Particular emphasis was placed on being able to interface with Stratford's part geometry file since LW is in the process of taking over the production of a Stratford turbine engine product.

- LW currently employs 15 draftsmen. They belong to the United Autoworkers union.

  - The drawing files consist of originals that are vulnerable to being lost by fire.

- No finite element analysis is being done.

- All engineering documentation is on hard copy and not available through terminals to a computer data base.

- All N/C tape preparation is currently being done manually.

2. CAM STATUS

- Approximately 65 N/C machine tools are installed.

  - N/C controllers include Bendix, GE, Cincinnati Milicron and Allen-Bradley (A&B).

  - The latter are considered to be the best choice, but LW has been experiencing some service problems with A&B lately.

- All training of N/C operators is done in-house because industrial electronics experience is hard to obtain in Williamsport.

  - The average age of the machine tool operators appears to be in the 50-65 year old bracket. This is typical of the age of skilled machinists in the United States today.

- Eight CNC machines are installed.

- A K&T Moduline flexible machining center is installed.

  - Phase I (standalone) has been completed.

  - Phase II (DNC to a pair of Interdata minicomputers) is being completed.

  - This FMS was justified more on a need to increase production capacity than on cost savings.

  - It has been in place about two years.

- Piston engines are tested in test cells using minicomputers to collect the data.

  - Real time data acquisition and control systems are used to record the test data.

  - A second turnkey test system is currently being installed and debugged.

- There are 27 basic engine type certificates, but over 500 variations of the product line.

- A tour of the production and engineering facilities showed that the buildings are very old.

  - The facility contains 800,000 square feet.

  - Some buildings were constructed at the turn of the century.

  - One section is being torn down this summer, and a new production line will be put into the new facility.

- The machine tool ages are as follows:

Age	% of Total	No. of Machines
0-5 yrs	8	126
5-10 yrs	2	36
10-20 yrs	19	303
20-30 yrs	15	233
30-40 yrs	46	712
over 40 yrs	10	157
	100	1,567

3. MANUFACTURING CONTROL STATUS

- An IBM 370/125 is currently being used for DP functions.
  - This computer uses the DOS/VS operating system which IBM will only support after 1981 under a fee-based maintenance contract.
  - There are plans to upgrade to an IBM 4341, but these have not yet been approved.
  - There are 18 people in the data processing organization.
- Manufacturing control systems that are currently supported by the S-370/125 include the following applications:
  - PICS (includes MRP).
  - Field Service and engine registration information system.
  - Daily material/parts shortages report for manufacturing.
  - Project control.
  - Plant/manpower efficiency data.

- Until the new mainframe is in place, there is no incentive to install new systems on the 370/125, even if it were capable of handling the load.

B. CAD/CAM: PERCEIVED NEEDS

- Exhibit V-3 lists the CAD/CAM needs as perceived by LW.
  - The needs are current (1981-1982).
  - The high rating indicates that documentation exists which explains the basis of the need and the general objectives for satisfying it during the calendar year 1981.
  - A medium rating indicates that this need was discussed at presentations to the study team, but may not be in a documented plan.
  - The low rating indicates that this need was informally mentioned to one or more members of the study team during its plant tour or during informal discussions.
  - Where there is an asterisk opposite the function, either there was no mention of the need by LW management, or the need was not perceived to fall within the 1981-1982 timeframe.
- On a weighted basis, LW ranks last out of six manufacturing divisions for total CAD/CAM needs, as shown in Exhibit II-8.
  - CAD requirements account for the highest level of divisional needs with 54% of the applicable CAD functions.
  - CAM needs represent 35% of the total potential CAM functions.

EXHIBIT V-3

LYCOMING/WILLIAMSPORT DIVISION:
PERCEIVED CAD/CAM/MCS NEEDS 1981-1982

CAD		CAM		MANUFACTURING CONTROL SYSTEMS	
SYSTEM SELECTION	HIGH	N/C TOOLS	HIGH	BILL OF MATERIAL	*
SYSTEM GROWTH	X	CNC	HIGH		
SYSTEM INSTALLATION	HIGH	DNC	LOW	MATERIAL CONTROL	*
DESIGN		FMC	HIGH		
- MECHANICAL	HIGH			MATERIALS REQ. PLANNING	*
- ELECTRICAL	X	MATERIALS HANDLING			
- ARCHITECTURAL	*	- STORAGE AND RETRIEVAL	*	PURCHASING	*
- TOOLING	MEDIUM	- WAREHOUSE	*		
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE	HIGH	PROCESS AND ROUTING	*
- DRAFTING	HIGH	- GUIDED VEHICLE SYSTEMS	*		
ANALYSIS		- ROBOT	*	SHOP FLOOR CONTROL	*
- FEA	LOW	- OTHER	*		
- THERMAL	*			CAPACITY PLANNING	*
- INTEGRATED CIRCUIT	*	ASSEMBLY			
- THREE DIMENSIONAL	LOW	- ROBOT	*	STANDARD COSTING	*
- OTHER	*	- OTHER	*		

*NO 1981 PERCEIVED NEEDS
X = DOES NOT APPLY TO THIS DIVISION

EXHIBIT V-3 (CONT.)

LYCOMING/WILLIAMSPORT DIVISION:

PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL SYSTEMS	
DESIGN RETRIEVAL	HIGH	INSPECTION AND TEST	X	MASTER SCHEDULING	*
		- ELECTRONIC	*		
N/C CAPABILITIES	X	- MECHANICAL	HIGH	ORDER ENTRY	*
- TAPE PREP	MEDIUM	- SYSTEMS	HIGH		
- TOOL OPTIM.	*	- PROCESS	*	FIELD SERVICE	HIGH
ENGINEERING DATA BASE	HIGH			MAINTENANCE CONTROL	*
		ROBOTICS	X		
MANUFACTURING PROCESS DOC.	MEDIUM	- WELDING	*	TOOL AND GAUGE CONTROL	*
		- PAINTING	*		
MODELING	*	- OTHER	*	GROUP TECHNOLOGY	*
OTHER	COMM. HIGH			FACTORY DATA COLLECTION	X
				- BATCH I/O	MEDIUM
				- ON-LINE	*
		FACILITIES MANAGEMENT	MEDIUM		

*NO 1981 PERCEIVED NEEDS

- Manufacturing control systems are only 11% of the total potential MCS functions. Exhibit V-4 portrays these relationships.

I. CAD: PERCEIVED NEEDS

- The high and immediate need to select a CAD system is enhanced by the imminent transfer of turbine engine production from Stratford to Williamsport.

  - There are approximately 400 drawings per LT 101 model and about 3,000 drawings for all nine models. About 2,000 drawings need to be developed by Stratford.

  - Williamsport needs up-to-date drawings as soon as an EO is made in Stratford.

  - Williamsport needs some way to transfer current drawings and the engineering changes via an electronic communications link to Stratford.

    . Several hardware and software alternatives have been proposed for LW's evaluation.

- A plan to implement CAD at LW was presented to the study team.

  - This plan calls for the CAD system to be installed at the end of 1981.

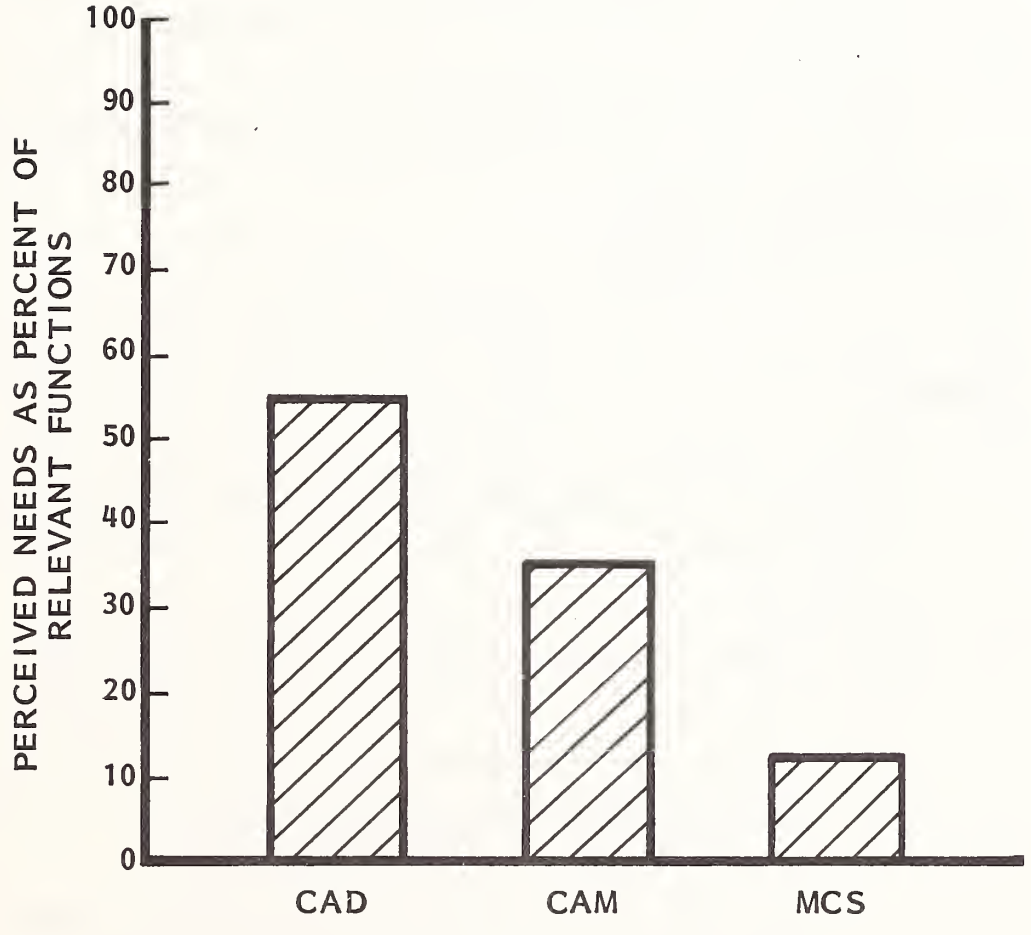
  - Unigraphics software would provide compatibility with Stratford's CAD system.

  - CAD/CAM software is being evaluated at LW.

  - It is expected to take one year for system familiarization, but incorporation of drawings on the CAD system is expected to begin in mid-1982.

EXHIBIT V-4

PERCEIVED CAD/CAM NEEDS
LYCOMING/WILLIAMSPORT DIVISION: 1981-1982



- Finite element analysis capability is expected to begin in 1984.

  - Direct CAD to CAM systems will start at the beginning of 1985.

- Other current CAD needs are shown in Exhibit V-4.

- Basic to the piston engine family, common components between engine models allow efficient use of CAD opportunities.

  - The aircraft piston engine is a mature development.

  - Heavy emphasis is placed on flexibility of configuration.

  - There are approximately 32,000 drawings maintained in Engineering.

2. CAM: PERCEIVED NEEDS

- The most immediate CAM need is to upgrade the N/C tape programming capability.

  - Currently there is no way to try out a new tape except by pilot manufacturing.

  - This is expensive and time consuming. There is a need to:

    . Install computer-aided N/C tape generation capability to increase programming productivity.

    . Get drawings into data base file for on-line access.

    . Produce drawings automatically.

    . Provide drawing configuration management.

- Other needs include:

  - The current upgrade to the level of machine tool automation.

  - Automated mechanical test and inspection systems.

  - Automated tool and gauge control system.

- The replacement of old factory facilities also are high priorities.

3. MANUFACTURING CONTROL: PERCEIVED NEEDS

- The major near-term need for manufacturing control systems applications is to upgrade the existing IBM 370/125 mainframe DP computer.

  - A more powerful system is required that will permit on-line data files for use by both production and engineering.

  - The exact requirement for processing power depends upon the support that is required for the CAD software, particularly for design analysis such as finite element analysis.

- Once there is a more powerful DP mainframe installed, the opportunities for improving the existing manual methods of manufacturing control are potentially very high.

  - These have not yet been defined, however.

C. INITIAL ASSESSMENT FOR CAD/CAM

- The corporate study team has made an initial assessment for CAD/CAM development at each of the AVCO manufacturing divisions.

- These judgements are based upon:

  . The current status of the divisions.

  . The level of management commitment.

  . The extent of need for CAD/CAM for the division's competitive position.

  . The ability of existing division personnel to accomplish the CAD/CAM objectives.

- Also considered were:

  . Anticipated growth of the division.

  . Age of existing facilities and equipment.

  . Impact of CAD/CAM capabilities on obtaining future business.

  . The potential value of CAD/CAM investment upon the division's current product mix.

I. CAD ASSESSMENT

- Exhibit V-5 shows that LW is at the starting point for CAD development.

  - The pressure to get some automation assistance for both drawing production and for N/C tape programming will promote the immediate evaluation of a CAD system.

  - Once installed, the other benefits for greatly increased engineering and production productivity will become evident.

EXHIBIT V -5

LYCOMING/WILLIAMSPORT DIVISION:
STUDY TEAM ASSESSMENT OF CAD/CAM
IN 1981-1982 RELATIVE TO OTHER AVCO DIVISIONS

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	NONE	BELOW AVERAGE	AVERAGE
MANAGEMENT .COMMITMENT	HIGH	ABOVE AVERAGE	AVERAGE
COMPETITIVE POSITION*	BELOW AVERAGE	AVERAGE	AVERAGE
IN-HOUSE CAPABILITIES	LOW	AVERAGE	AVERAGE
ANTICIPATED GROWTH	HIGH	HIGH	BELOW AVERAGE
EQUIPMENT AGE	N/A	35-40 YEARS	10-12 YEARS
IMPACT	HIGH	HIGH	AVERAGE
POTENTIAL FOR NEAR-TERM DEVELOPMENT	AVERAGE	BELOW AVERAGE	BELOW AVERAGE

*RELATIVE TO EXTERNAL COMPETITION

- The probabilities that the CAD system will grow both in power and functional capability is high.

- LW should be able to benefit from the accumulated experience of the three other divisions that have CAD systems already installed.

  - Compared to the other aircraft engine manufacturers, LW is probably below average.

  - As it moves into turbine engine production, the need for CAD system capabilities will increase.

- At present, the in-house capabilities are low since there are no experienced CAD users, nor are there graphics systems programmers.

  - It was indicated to the study team that such talent is not available in the Williamsport area.

  - It may be difficult to recruit this type of skill to the area.

- The growth outlook is high in the CAD area.

  - CAD could be used to help engineers design more efficient piston engines.

  - The LT 101 series of gas turbine engines, coupled with a CAD system capability, offers the potential for growth for the Williamsport Division.

- The impact of CAD upon the division is judged to be high because of:

  - The changing product mix to include turbines.

- The emphasis on the larger piston engines that are being used in the business market.

- Longer term, the development of CAD will permit the integration of CAD with CAM.

  - Williamsport is the only division out of all the AVCO manufacturing divisions that has a definite schedule for accomplishing this integration.

2. CAM ASSESSMENT

- The current level of CAM at LW is judged to be below average.

- The management commitment to CAM is above average.

- Due to the age of the machines and the production facility, the competitive position is below average, not only for the industry, but also within AVCO manufacturing divisions.

  - It will be difficult to:

    . Remove the old equipment.

    . Refurbish the buildings.

    . Install new CAM systems.

- The capability to utilize CAM is judged to be average because of the experience with the FMS.

  - The existing workforce will have to be trained on the use of all of these systems plus robotics, if they are utilized.

- The impact of CAM upon the division will be high.

- It will be subsequent to and linked to the CAD system.

- The relatively low level of existing CAM means that there will be many opportunities for LW to improve its productive capabilities through new CAM systems, but in the 1981-1982 timeframe the estimate for CAM development is judged to be only average.

3. MANUFACTURING CONTROL ASSESSMENT

- The level of manufacturing control systems is judged to be average.

  - The IBM 370/125 lacks the capacity to do much more than it is currently doing.

  - Management appears committed to upgrade the computer, but it needs to be certain that the replacement will be able to support CAD, CAM and the more sophisticated manufacturing control systems.

- The anticipated growth in manufacturing control is expected to be below average because of the magnitude of other tasks that are yet to be done.

  - The impact of manufacturing control systems upon LW will be about average.

- The near-term potential for manufacturing control development is judged to be below average.

D. CONCLUSIONS AND RECOMMENDATIONS

- The current CAD/CAM status of Lycoming/Williamsport is below average.

- The needs are high, not only for piston engine development but also for CAD to assist on the drawings and engineering data base associated with the LT 101 turbine engine production.

- The immediate needs for CAM are above average.

  - CAM implementation plans have been developed at LW, but they have not been given to the corporate study team.

- The needs for manufacturing control are the least of the three (CAD, CAM, MCS) categories.

- As shown in Exhibit V-6, the potential for near-term development of CAD functions is judged to be average.

  - In the near term, both CAM and manufacturing control potential are below average.

- The study team recommends that the implementation of the CAD system be given a high divisional priority.

  - If the proposed schedule can be accelerated, it would appear to be beneficial because of the urgent nature of the LT 101 transfer.

  - The installation of the CAD system will ease the development of CAM since the CAD system can help in the generation of N/C tapes and programs, thus making the utilization of CNC machine tools more viable than is currently possible.

- It is also recommended that the upgrade of the IBM 370/125 be made as early as possible.

EXHIBIT V-6

LYCOMING/WILLIAMSPORT DIVISION: OVERALL CONCLUSIONS BY STUDY TEAM

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	LOW	BELOW AVERAGE	BELOW AVERAGE
PERCEIVED NEEDS	HIGH	ABOVE AVERAGE	AVERAGE
POTENTIAL FOR NEAR TERM	AVERAGE	BELOW AVERAGE	BELOW AVERAGE

- The replacement should be selected, so that manufacturing control, as well as good communications with Stratford, will be possible with the new computer.

- A final recommendation is that LW should take advantage of the CAD selection and implementation experiences of the Stratford, Aerostructures and Electronics Divisions.

  - Since the Systems and New Idea Divisions are also evaluating the procurement of a CAD system, these organizations would also be likely to want to share their assessments and vendor analysis with Williamsport.

VI LYCOMING/STRATFORD DIVISION

VI LYCOMING/STRATFORD DIVISION

A. CAD/CAM STATUS

- The current level of CAD/CAM activity at the Stratford Division (SD) was investigated by the corporate study team.
  - The level is measured against all the potental CAD/CAM functions as defined in Chapter II, the Executive Summary.
  - These functions are interrelated, as was explained during the initial presentation that was made to SD during the study team's visit to Stratford on January 20, 1981.
  - Exhibit VI-1 shows these relationships.
- Exhibit VI-2 shows the areas and levels of existing activity related to CAD/CAM and automated manufacturing control systems.
  - These activities are derived from four primary sources:
    - Documented plans that were given to the study team during its initial visit.
    - Presentations made by SD management.

EXHIBIT VI-1

CAD/CAM INTEGRATION

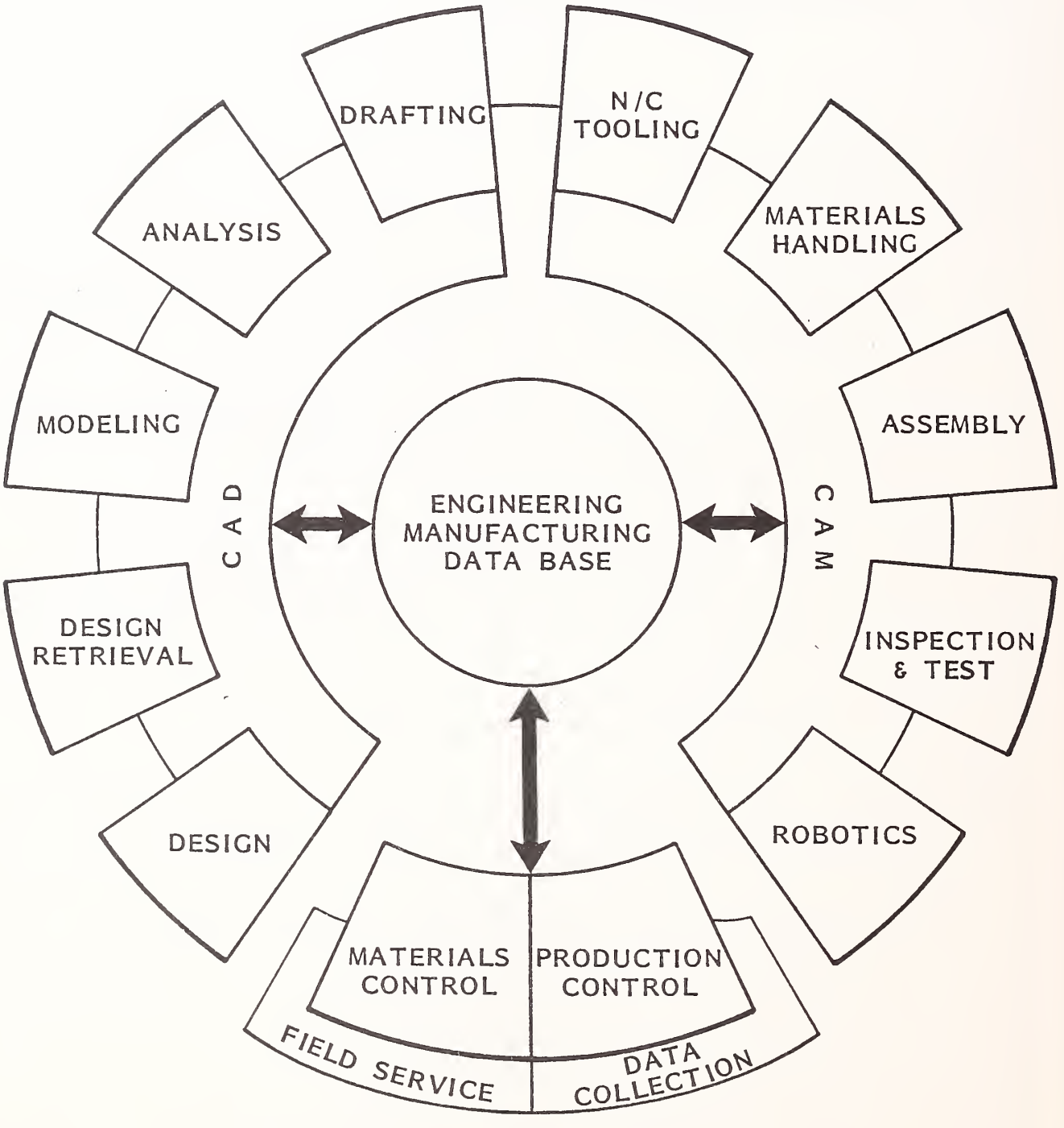


EXHIBIT VI-2

LYCOMING/STRATFORD DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	UNI-GRAPHICS	N/C TOOLS	(1) 64 / 25 (2)	BILL OF MATERIAL	IN-STALLED
SYSTEM GROWTH	STUDY	CNC	15 / 3 YRS.		
SYSTEM INSTALLATION	IN-STALLED	DNC	STUDY / X	MATERIAL CONTROL	IN-STALLED
DESIGN		FMC	2 / 2		
- MECHANICAL	IN-STALLED			MATERIALS REQ. PLANNING	IN-STALLED
- ELECTRICAL	IN-STALLED	MATERIALS HANDLING			
- STRUCTURAL	IN-STALLED	- STORAGE AND RETRIEVAL	IN-STALLED	PURCHASING	STUDY
- TOOLING	IN-STALLED	- WAREHOUSE	*		
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE	IN-STALLED	PROCESS AND ROUTING	IN-STALLED
DRAFTING	IN-STALLED	- GUIDED VEHICLE SYSTEM	*		
ANALYSIS		- ROBOT	*	SHOP FLOOR CONTROL	IN PROCESS
- FEA	IN-STALLED	- OTHER	*		
- THERMAL	IN-STALLED			CAPACITY PLANNING	IN PROCESS
- IC	*	ASSEMBLY			
- THREE DIMENSIONAL	IN-STALLED	- ROBOT	*	STANDARD COSTING	IN-STALLED
- OTHER	IN-STALLED	- OTHER	*		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT
(1) NUMBER INSTALLED
(2) AVERAGE AGE
X = DOES NOT APPLY

EXHIBIT VI-2 (CONT.)

LYCOMING/STRATFORD DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	IN-STALLED	INSPECTION AND TEST		MASTER SCHEDULING	*
		- ELECTRONIC	*		
N/C CAPABILITIES		- MECHANICAL	IN-STALLED	ORDER ENTRY	*
- TAPE PREP	IN-STALLED	- SYSTEMS	IN-STALLED		
- TOOL OPTIM.	*	- PROCESS	*	FIELD SERVICE	IN-STALLED
ENGINEERING DATA BASE	IN PROCESS			MAINTENANCE CONTROL	STUDY
		ROBOTICS			
MANUFACTURING PROCESS DOC.	*	- WELDING	STUDY	TOOL AND GAUGE CONTROL	IN- PRO-GRESS
		- PAINTING	*		
MODELING	IN-STALLED	- OTHER	*	GROUP TECHNOLOGY	STUDY
OTHER	STUDY			FACTORY DATA COLLECTION	
				- BATCH I/O	IN-STALLED
				- ON-LINE	IN-STALLED
		FACILITIES MANAGEMENT	*		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT

- Notes prepared by members of the study team based upon individual and group discussions with SD personnel.

- Trip reports prepared by Norm Bernstein.

- Discussions with divisional management during return visits to Stratford by the Study Team on February 12 and May 27, 1981.

1. CAD STATUS

- Stratford has the most advanced CAD system of all AVCO manufacturing divisions.

- The hardware consists of:

  - DEC PDP-11/70 minicomputer.

  - Six Tektronix 4014 monochrome vector CRT workstations.

  - CalComp 960 vertical bed graphics plotter.

  - Versatec 22" electrostatic graphics plotter.

  - High-speed telecommunications link to IBM 3033 mainframe via SAI.

  - Uninterruptable feeder line power supply system.

- Software consists of:

  - McAuto Unigraphics.

  - GRIP graphics programming language.

  - N/C tool path generation program used on the IBM 3033.

- WIRE FRAME three-dimensional data base for drafting functions, 3-D surfaces, finite element models, schematics and N/C tool path geometry.

- In addition, the host IBM 3033 has three to four hundred engineering and scientific programs, including:

  - Finite element analysis; MSC/NASTRAN, FEATS, ABAQUS, NONSAP.

  - Structural, stress, mathematical, aerodynamic design, heat transfer, gear/bearing, etc.

  - IBM APT/AC numerical control programming.

- Other hardware associated with the IBM 3033 used for graphics applications, including business, are:

  - CalComp 748 flatbed plotting system (approximately five feet by six feet).

  - Versatec electrostatic plotters: one 12", one 36".

  - IBM 3277 graphics attachment.

    . IBM 3277 terminal.

    . Tektronix 618 storage monitor.

  - IBM 2250 ICG system (limited use).

  - IBM 3279 color graphics terminal.

- Stratford has found that its experience with its CAD system has been very positive.

- It has become a fundamental engineering design tool without which Stratford would be unable to meet its sophisticated product requirements.

- An engineering data management system is being developed.

2. CAM STATUS

- The Stratford plant area covers 77 acres with 1.5 million square feet of factory and office space.

  - There are 1,600 machine tools in use.

  - The plant is relatively old, having been built during World War II. It is a government-owned facility.

  - There are about 5,000 employees, of which about 3,000 are in production and quality control functions.

- The primary production concern currently is the AGT 1500 turbine engine that is used in the new ABRAMS military tank.

  - The technical problems appear to have been solved.

  - The potential for a long and profitable production run of this product appears likely.

- As shown in Exhibit VI-2, the number of N/C tools (66 machines) is about 4% of the total machine tools that are installed.

- There is no DNC capability now, but SD is evaluating the use of IBM Series/1 and other computers for this application.

- A flexible machining center is installed.
  - It is a Kearny & Trecker turnkey FMC with 11 K&T and three Bullard machines with an automated material delivery system.
  - This installation is designed to machine a variety of parts, mostly large housings for the AGT-1500.
  - There are both historical and current problems in the operation of the K&T FMS.
- Ultimately the FMS is expected to operate three shifts/day and produce 12 parts, each requiring 61 operations, with a throughput from start to finish of 48 hours.
  - The justification for the purchase of this system was not so much based upon economics, as it was predicated upon the need for throughput capacity.
- The other major area of fabrication automation is the Sciaky recuperator production line.
  - This center includes the largest sheet metal press in the world, a six-station Verson punch press.
  - At 75% of capacity, this center produces 3,600 recuperator plates per day with a 12 hours/day operation.
  - Automated material handling moves parts between machines.
  - A Sciaky dial feed machine assembles and tests in process 280 plates per recuperator.

- Tolerances are very close, but the center has primarily operated as expected.

- Elsewhere in the factory many old machine tools, some left over from World War II are still in use.

- Most parts are moved either by forklift trucks or by hand and machine. Loading and unloading are mostly manual.

- No robots are in use.

- An automated finished stores storage and retrieval system is being implemented on an IBM 8100 computer.

  - Further materials handling automation is planned for tool and gauge storage and retrieval using the IBM 8100 distributed computer system.

- By using IBM equipment, Stratford has been able to establish a hierarchical network of computers that can communicate.

  - This will greatly ease the difficulties in later stages of CAM evolution when integrated CAM systems are established.

- There is no automated assembly equipment.

- There is computer-based inspection for coordinate measuring.

- Numerous automated data acquisition and control systems have been installed for engine test. These include systems for:

  - Engine component test.

  - Development engine test.

  - Production engine test.

- Systems in use are: IBM, DEC, & Hewlett-Packard.

- Other test automation includes:

  - An HP computer used for X-ray diffraction pattern sampling.

  - A DEC PDP 11/34 used for fatigue/ultrasonic material test.

  - An HP 1000 for fuel nozzle analysis.

  - An airborne HP 1000 for collecting in-flight test data.

- Factory floor data collection consists of DATA PATHING batch I/O data collection terminals linked via tape I/O on a DPI processor to the host computer.

  - The system does not encompass all the manufacturing areas.

3. MANUFACTURING CONTROL STATUS

- Currently there are two bills of material at Stratford.

  - One for engineering.

  - One for manufacturing.

  - These are implemented on the host IBM 3033 computer under Chain File Management System (CFMS).

- The On-Line Monitor is being replaced by a more powerful software system called CICS.

- IMS/COPICS is planned to replace CFMS.

- Other manufacturing control systems functions that use the CFMS software include:
  - Material control.
  - Material requirements planning.
  - Process and routing.
  - Standard costing.
  - Master scheduling.
- An automated Purchasing System is being evaluated, as is an Order Entry system.
- Machine tool maintenance control is manual at present, but automated systems are planned in these areas using an IBM 8100 system.

B. CAD/CAM: PERCEIVED NEEDS

- Exhibit VI-3 lists the CAD/CAM needs as perceived by Stratford.
  - The needs are current (1981-1982).
  - The high rating indicates that documentation exists which explains the basis of the need and the general objectives for satisfying it during the calendar year 1981/1982.
  - A medium rating indicates that this need was discussed at presentations to the study team, but may not be in a documented plan.

EXHIBIT VI-3

LYCOMING/STRATFORD DIVISION:

PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	MEDIUM	N/C TOOLS	LOW	BILL OF MATERIAL	HIGH
SYSTEM GROWTH	HIGH	CNC	HIGH		
SYSTEM INSTALLATION	*	DNC	HIGH	MATERIAL CONTROL	HIGH
DESIGN		FMC	HIGH		
- MECHANICAL	HIGH			MATERIALS REQ. PLANNING	HIGH
- ELECTRICAL	*	MATERIALS HANDLING			
- STRUCTURAL	*	- STORAGE AND RETRIEVAL	HIGH	PURCHASING	HIGH
- TOOLING	LOW	- WAREHOUSE	*		
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE	HIGH	PROCESS AND ROUTING	HIGH
- DRAFTING	HIGH	- GUIDED VEHICLE SYSTEMS	*		
ANALYSIS		- ROBOT	*	SHOP FLOOR CONTROL	HIGH
- FEA	*	- OTHER	*		
- THERMAL	*			CAPACITY PLANNING	HIGH
- IC	*	ASSEMBLY			
- THREE DIMENSIONAL	HIGH	- ROBOT	*	STANDARD COSTING	*
- OTHER	*	- OTHER	*		

*NO 1981 PERCEIVED NEEDS
X = DOES NOT APPLY

EXHIBIT VI-3 (CONT.)

LYCOMING/STRATFORD DIVISION
PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	*	INSPECTION AND TEST	X	MASTER SCHEDULING	HIGH
		- ELECTRONIC	*		
N/C CAPABILITIES	X	- MECHANICAL	HIGH	ORDER ENTRY	HIGH
- TAPE PREP	HIGH	- SYSTEMS	HIGH		
- TOOL OPTIM.	HIGH	- PROCESS	*	FIELD SERVICE	HIGH
ENGINEERING DATA BASE	HIGH			MAINTENANCE CONTROL	HIGH
		ROBOTICS	X		
MANUFACTURING PROCESS DOC.	HIGH	- WELDING	HIGH	TOOL AND GAUGE CONTROL	HIGH
		- PAINTING	*		
MODELING	HIGH	- OTHER	*	GROUP TECHNOLOGY	HIGH
OTHER	HIGH			FACTORY DATA COLLECTION	X
				- BATCH I/O	*
				- ON-LINE	MEDIUM
		FACILITIES MANAGEMENT	X		

*NO 1981 PERCEIVED NEEDS
X = DOES NOT APPLY TO THIS DIVISION

- The low rating indicates that this need was informally mentioned to one or more members of the study team during its plant tour or during informal discussions.

- Where there is an asterisk opposite the function, either there was no mention of the need by Stratford management, or the need was not perceived to fall within the 1981-1982 timeframe.

- On a weighted basis, Stratford ranks second out of six divisions for total CAD/CAM needs, as shown in Exhibit II-8.

  - Manufacturing control functions are the most needed with 85% of the relevant perceived needs.

  - CAD functional needs account for 55% of the total potential CAD applications.

  - CAM requirements account for 49% of the relevant CAM functions; Exhibit VI-4 shows these relationships.

I. CAD: PERCEIVED NEEDS

- Computer-based automation at Stratford is a joint responsibility of the user and MIS departments.

- Exhibit VI-4 shows that there is a high need for increasing the number of interactive graphic workstations.

  - Current plans are to add more Tektronix vector monocolor terminals with appropriate I/O devices to the system.

- Another high need is to improve the surface geometry capability for design analysis applications such as turbine blade design, installation drawings, tool design, etc.

- Another high priority CAD need is the development of manufacturing process documentation and modeling capabilities.

- Longer range and additional CAD needs include:

  - Tool design.

  - Increased automated drafting.

  - Development of an on-line engineering data base system.

2. CAM: PERCEIVED NEEDS

- MIS has documented the needs for 1981.

- For CAM these needs are as follows:

  - Optimized production timetable simulation modeling (OPT).

  - Finished stores inventory system.

  - Equivalent engine coverage system.

  - Shop floor control system.

  - Machine maintenance system.

  - Direct Numerical Control (DNC).

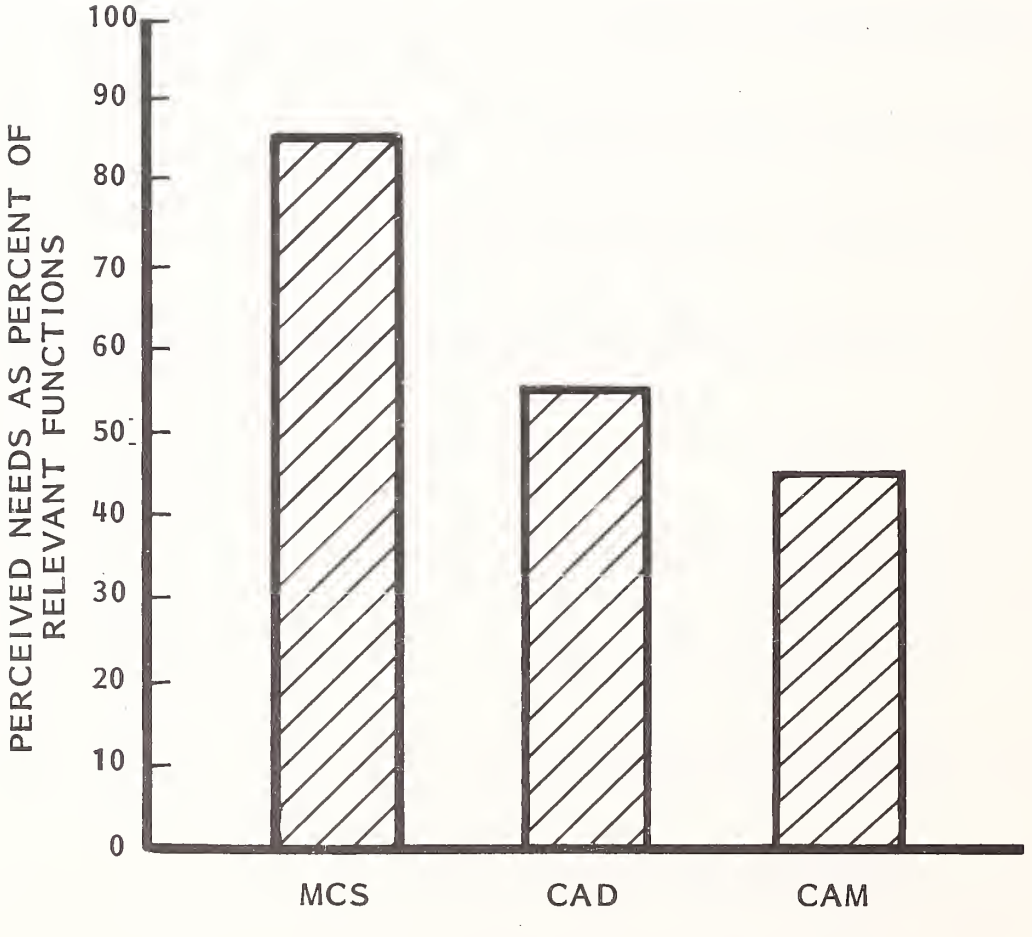
  - Material management and technology.

  - Automated machining line enhancements (FMS, SCIAKY).

  - Perishable tooling system.

EXHIBIT VI-4

PERCEIVED CAD/CAM/MCS NEEDS
LYCOMING/STRATFORD DIVISION: 1981-1982



- Nearly all the CAM functions that are shown in Exhibit VI-3 are included in a list of long-range interests assembled by the MIS department.

  - This list includes:

    . Group technology.

    . Computer-aided assembly.

    . Micro/minicomputer utilization.

    . CAM using graphics.

    . Automated process planning.

    . Computer simulation of processes/methods.

    . Robotics.

    . Material handling/storage.

    . Computer-aided tool design.

    . Computer numerical control (CNC).

    . Design/manufacturing interface.

    . Adaptive control.

    . Distributed data processing in manufacturing.

    . Numerical control programming.

- Only those functions that are listed in Exhibit VI-3 are near-term (1981-1982) needs.

3. MANUFACTURING CONTROL: PERCEIVED NEEDS

- Proposed systems and programming needs that are documented in the Stratford 1981 management information plan include the following requirements:

  - Industrial engineering.

    . Pure bill of material system.

    . Capacity planning analysis system.

  - Quality.

    . Automated engine log data.

    . Automated data for part serial number traceability.

    . Automated rework and repair.

  - Material control/purchasing.

    . Replacement of control system. COPICS is being considered.

C. INITIAL ASSESSMENT FOR CAD/CAM

- The corporate study team has made an initial assessment for CAD/CAM development at each of the AVCO manufacturing divisions.

  - These judgements are based upon:

- . The current status of the divisions.
- . The level of management commitment.
- . The extent of need for CAD/CAM for the division's competitive position.
- . The ability of existing division personnel to accomplish the CAD/CAM objectives.

- Also considered were:
  - . Anticipated growth of the division.
  - . Age of existing facilities and equipment.
  - . Impact of CAD/CAM capabilities on obtaining future business.
  - . The potential value of CAD/CAM investment upon the division's current product mix.

- Eleven priority items have been recommended but have not all been approved by management. Seven of the items and their status are as follows:
  - Currently being implemented:
    - . Optimized Production Timetable (OPT).
    - . Finished stores inventory system.
    - . Machine maintenance system.
  - Proposed but requires detailed feasibility study:

. Equivalent engine coverage system.

. Shop floor control system.

. Purchasing control system.

. COPICS.

I. CAD ASSESSMENT

- As shown in Exhibit VI-5, the current status of CAD at Stratford is judged to be high.

  - Without question, the Division has the most capable system for CAD in the AVCO Corporation, and the personnel are the most experienced in its use.

  - There is room for growth, both in the quantity of workstations and other hardware and software, and in the quality of the work that is assigned to CAD, such as the development of a direct CAD to CAM (DNC) capability.

- SD management is committed to the CAD functions and their successful applications to Stratford engineering requirements.

- Compared to other aerospace engine manufacturers, Stratford is probably average for the industry.

- The potential for increased growth in the use of CAD is also judged to be high.

- The equipment and the software are only two to three years old. Examples of equipment and software future enhancement include:

  - Color terminals.

EXHIBIT VI-5

LYCOMING/STRATFORD DIVISION:
STUDY TEAM ASSESSMENT OF CAD/CAM DEVELOPMENT
IN 1981-1982 RELATIVE TO OTHER AVCO DIVISIONS

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	HIGH	ABOVE AVERAGE	HIGH
MANAGEMENT COMMITMENT	HIGH	HIGH	HIGH
COMPETITIVE POSITION*	AVERAGE	BELOW AVERAGE	AVERAGE
IN-HOUSE CAPABILITIES	HIGH	ABOVE AVERAGE	AVERAGE
ANTICIPATED GROWTH	HIGH	HIGH	HIGH
EQUIPMENT AGE	2-3 YEARS	20 YEARS	5 YEARS
IMPACT	HIGH	HIGH	ABOVE AVERAGE
POTENTIAL FOR NEAR-TERM DEVELOPMENT	ABOVE AVERAGE	BELOW AVERAGE	ABOVE AVERAGE

*RELATIVE TO EXTERNAL COMPETITION

- Three-dimensional volumetric surfaces.

- More computer power able to handle future user requirements.

- There are communication problems between the 3033 and the 11/70. Other problems are response time limitations.

  - There is no question but the impact of CAD upon Stratford is dramatic and will be even more dramatic in the future.

2. CAM ASSESSMENT

- Compared to other AVCO divisions, Stratford is above average for the level of CAM implementation.

- Since CAD is relatively well developed at the division, the next few years should see an emphasis on CAM.

- The current management commitment to CAM appears to be high; detailed plans are being prepared.

- While Stratford CAM status is higher than in other AVCO divisions, its competitive position relative to other industry competitors is judged to be below average.

  - For example, only 4% of the machine tools are N/C.

  - The manufacturing facilities are old and appear to be inefficiently layed out.

  - There are plans to use robots.

  - The factory data collection system is outdated.

- Based upon the study team plant tours, the in-house CAM capabilities appear to be above average.

  - The FMS, which is a critical part of the AGT 1500 production capability, was down because of unknown problems, which are being addressed.

  - On the other hand, the Sciaky line appeared to be functioning well, and the management appeared to be very capable.

- The anticipated growth will be high because of the need to increase capacity and because of the below average competitive position at present.

- The average age of the manufacturing equipment is about 20 years according to manufactuing personnel with whom the study team talked during its plant tours.

- The impact of CAM will be high.

  - Current as well as proposed projects will significantly improve both plant capacity and productivity.

3. MANUFACTURING CONTROL ASSESSMENT

- All the criteria against which the assessment in the manufacturing control area were measured were judged to be average.

- The installed systems are inadequate.

  - The size of the installation, the capabilities of the EDP personnel, and the fact that serious five-year plans have been developed, documented and evaluated all lead to the conclusions that the impact of manufacturing control upon the division will be above average in the near term.

D. CONCLUSIONS AND RECOMMENDATIONS

- At Stratford the CAD level of activity is the highest of all AVCO divisions, as shown in Exhibit VI-6.

  - However for the industry the level of development is judged to be only average since only six workstations are currently on-line.

  - This is a minimum level considering the design and engineering workload at the plant.

- The CAM level is above average compared to other AVCO divisions, but, as discussed earlier, it is below average for the aerospace industry.

- Manufacturing control systems status is below average.

- The highest perceived needs at Stratford are for improvements in the manufacturing control area.

- The potential for factory automation is judged to be very uneven at Stratford.

  - The potential for engineering applications of CAD in the near-term is above average.

    . The staff capabilities, the level of planning, the extent of the facilities and the age of the equipment are all above average.

  - For CAM, the near-term potential is below average.

    . The need for costly CAM investment while maintaining an uninterrupted production output puts a strain on CAM developments.

EXHIBIT VI-6

LYCOMING/STRATFORD DIVISION: OVERALL CONCLUSIONS BY STUDY TEAM

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	HIGH	AVERAGE	BELOW AVERAGE
NEEDS	AVERAGE	ABOVE AVERAGE	HIGH
POTENTIAL FOR NEAR TERM	ABOVE AVERAGE	BELOW AVERAGE	AVERAGE

- For manufacturing control, the near-term potential is below average because of the magnitude and complexity of the needs.

- The study team recommends that Stratford develop an extensive plan for CAM utilization.

  - In particular, the division should consider the benefits to be derived from:

    . Replacing old machine tools with CNC equipment.

    . Increasing N/C tape development using CAD systems.

    . Integrating of part numbering systems between engineering and manufacturing so that a common database can be structured and implemented.

    . Utilizing robots for machine loading and offloading applications, as well as other materials handling functions.

    . Applying group technology concepts to improve the existing plant layout. This will reduce work in process investments, make better utilization of existing tooling, improve the production capacity capabilities.

- In the CAD area, increased numbers of workstations, more automated drafting to replace the drawing boards, training of additional engineers in the use of CAD systems, and an upgrade to the PDP 11/70 for Unigraphics system to permit faster response time, and the implementation of three-dimensional raster color terminals for part of the design function should be undertaken.

- An upgraded manufacturing control system is needed.

VII ELECTRONICS DIVISION

VII ELECTRONICS DIVISION

A. CAD/CAM STATUS

o The level of CAD/CAM activity at the Electronics Division (ED) is measured against the list of potential functions, as shown in Exhibit VII-1.

- These functions are interrelated as defined during the initial presentation that was made by the corporate study team at Huntsville on February 25, 1981.

- Exhibit VII-2 shows these functions.

1. CAD STATUS

• The area of highest ED management attention to CAD/CAM is the installation of the recently delivered Applicon CAD system.

- Components of this system include:

  . DEC PDP 11/34.

  . Three CONRAC monochrome graphic workstations.

  . One RAMTEK color graphic workstation.

EXHIBIT VII-1

ELECTRONICS DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	APPLI-CON	N/C TOOLS	(1) X / X (2)	BILL OF MATERIAL	IN-STALLED
SYSTEM GROWTH	STUDY	CNC	X / X		
SYSTEM INSTALLATION	IN-STALLED	DNC	X / X	MATERIAL CONTROL	IN-STALLED
DESIGN		FMC	X / X		
- MECHANICAL	X			MATERIALS REQ. PLANNING	IN-STALLED
- ELECTRICAL	IN-STALLED	MATERIALS HANDLING			
- STRUCTURAL	IN-STALLED	- STORAGE AND RETRIEVAL	X	PURCHASING	STUDY
- TOOLING	X	- WAREHOUSE	X		
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE	X	PROCESS AND ROUTING	IN-STALLED
- DRAFTING	IN-STALLED	- GUIDED VEHICLE SYSTEM	X		
ANALYSIS		- ROBOT	X	SHOP FLOOR CONTROL	IN-STALLED
- FEA	X	- OTHER	X		
- THERMAL	X			CAPACITY PLANNING	STUDY
- IC	IN-STALLED	ASSEMBLY			
- THREE DIMENSIONAL	X	- ROBOT	*	STANDARD COSTING	IN-STALLED
- OTHER	IN-STALLED	- OTHER	IN-STALLED		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT

(1) NUMBER INSTALLED

(2) AVERAGE AGE

X = NOT APPLICABLE FUNCTION FOR THIS DIVISION.

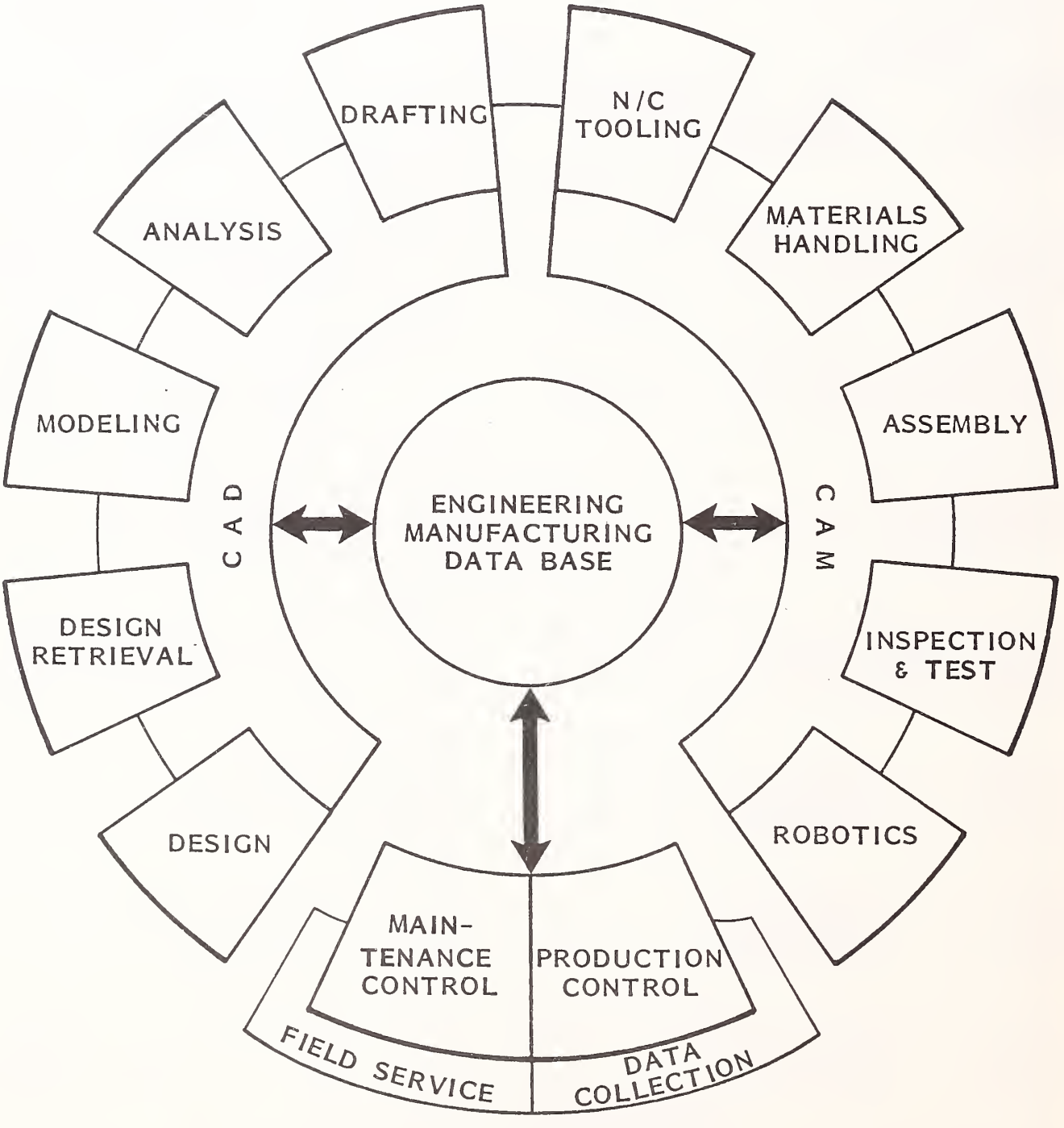
EXHIBIT VII-1 (CONT.)

ELECTRONICS DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	IN-STALLED	INSPECTION AND TEST		MASTER SCHEDULING	STUDY
		- ELECTRONIC	IN-STALLED		
N/C CAPABILITIES		- MECHANICAL	IN-STALLED	ORDER ENTRY	IN-STALLED
- TAPE PREP	IN-STALLED	- SYSTEMS	IN-STALLED		
- TOOL OPTIM.	IN-STALLED	- PROCESS	X	FIELD SERVICE	IN-STALLED
ENGINEERING DATA BASE	STUDY			MAINTENANCE CONTROL	STUDY
		ROBOTICS			
MANUFACTURING PROCESS DOC.	X	- WELDING	X	TOOL AND GAUGE CONTROL	IN-STALLED
		- PAINTING	X		
MODELING	IN-STALLED	- OTHER	IN-STALLED	GROUP TECHNOLOGY	X
OTHER	IN-STALLED			FACTORY DATA COLLECTION	
				- BATCH I/O	X
				- ON-LINE	IN-STALLED
		FACILITIES MANAGEMENT	STUDY		

EXHIBIT VII-2

CAD/CAM INTEGRATION



. Summagraphics data input tablet.

. Versatec electrostatic 36" graphic plotter.

. CalComp 960 plotter for large, high-resolution drawings.

- The selection of the Applicon system was based upon the following criteria:

  - The system is DEC-based (so is ED).

  - Software architectural (piping) capabilities.

  - Applicon's strong regional position in the southeast.

  - Availability of source code.

  - Thirty-day delivery.

  - Substantial discount off-list price.

  - Potential for upgrading to the acquisition of a DEC VAX 11/780.

  - Hands-on evaluation of the software system.

- The CAD system is being used to train ED operators.

  - It will be needed as soon as possible to produce 30,000 to 40,000 drawings for an Airport Security/Environmental Management System.

  - ED has a tight schedule to meet on its $60 million Saudi Arabian contract.

  - Without CAD automated design retrieval and drafting assistance, ED cannot meet the contractual deadlines.

- Training to full proficiency is expected to take about three months from date of delivery of the CAD system.

2. CAM STATUS

- ED is a contract electronics systems house.
  - Machine tools are not required, nor is CAM materials handling except for conveyors.
- There are two Universal component insertion machines.
  - There is also a Universal component sequence that feeds the automated insertion equipment.
- Automation is utilized for three General Radio PDP/8-based electronic PC board testers.
  - There is also an Autotest power supply testing system.
- Mechanical inspection of incoming parts is done with CORDAX coordinate (X,Y,Z,) measuring equipment.

3. MANUFACTURING CONTROL STATUS

- A DEC PDP 11/70 word processing system "on loan" from an Air Force contract is installed.
- An IBM System 34 is used for manufacturing control functions, as shown in Exhibit VII-1.
  - Of particular note is the telecommunications link (using MAPICS) to Riyadh.

- This permits close control over the installation of equipment in 42 buildings at the Saudi Arabian contract site (Riyadh Airport).

- ED has a strong DEC orientation for CAD/CAM processors.

  - There are 25 DEC-experienced programmers at ED.

  - There are several graphics programmers.

B. CAD/CAM: PERCEIVED NEEDS

- Current (1981) ED management perceived CAD/CAM needs are listed in Exhibit VII-3.

  - The high rating indicates that documentation concerning this function exists.

  - A medium rating indicates that this function was discussed during presentations to the corporate study team, but may not be documented in a plan.

  - The low rating indicates that this need was informally mentioned to one or more of the Study Team members during its facilities visit in Huntsville.

  - Where there is an asterisk, no mention was made of this function by ED management.

- On a weighted basis, ED ranked fourth out of six AVCO manufacturing divisions for total CAD/CAM needs.

  - CAD needs represent 67% of the total applicable CAD functions at ED.

EXHIBIT VII-3

ELECTRONICS DIVISION:
PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	X	N/C TOOLS	X	BILL OF MATERIAL	*
SYSTEM GROWTH	HIGH	CNC	X		
SYSTEM INSTALLATION	X	DNC	X	MATERIAL CONTROL	LOW
DESIGN		FMC	X		
- MECHANICAL	X			MATERIALS REQ. PLANNING	LOW
- ELECTRICAL	LOW	MATERIALS HANDLING			
- STRUCTURAL	HIGH	- STORAGE AND RETRIEVAL	X	PURCHASING	HIGH
- TOOLING	X	- WAREHOUSE	X		
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE	X	PROCESS AND ROUTING	*
DRAFTING	HIGH	- GUIDED VEHICLE SYSTEM	X		
ANALYSIS		- ROBOT	X	SHOP FLOOR CONTROL	*
- FEA	X	- OTHER	X		
- THERMAL	X			CAPACITY PLANNING	LOW
- IC	MEDIUM	ASSEMBLY			
- THREE DIMENSIONAL	X	- ROBOT	*	STANDARD COSTING	*
- OTHER	LOW	- OTHER	*		

*NO 1981 PERCEIVED NEEDS
X = NOT APPLICABLE FOR THIS DIVISION.

EXHIBIT VII-3 (CONT.)

ELECTRONICS DIVISION:

PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	HIGH	INSPECTION AND TEST		MASTER SCHEDULING	LOW
		- ELECTRONIC	MEDIUM		
N/C CAPABILITIES		- MECHANICAL	MEDIUM	ORDER ENTRY	*
- TAPE PREP	MEDIUM	- SYSTEMS	MEDIUM		
- TOOL OPTIM.	*	- PROCESS	X	FIELD SERVICE	LOW
ENGINEERING DATA BASE	LOW			MAINTENANCE CONTROL	LOW
		ROBOTICS			
MANUFACTURING PROCESS DOC.	X	- WELDING	X	TOOL AND GAUGE CONTROL	LOW
		- PAINTING	X		
MODELING	LOW	- OTHER	*	GROUP TECHNOLOGY	X
OTHER	MEDIUM			FACTORY DATA COLLECTION	
				- BATCH I/O	X
				- ON-LINE	*
		FACILITIES MANAGEMENT	MEDIUM		

- CAM and Manufacturing Control represent 38% and 24% respectively.

- Exhibit VII-4 shows these relationships.

1. CAD: PERCEIVED NEEDS

- The high CAD needs reflect management concern over producing drawings on schedule for the Security System contract.

  - Although of lower priority at present, the potential for PC board design, drill tape and artwork (especially the color workstation) is recognized.

  - N/C tape preparation is also planned to be added to the Applicon CAD system in the near future.

- Since ED works on single jobs rather than a continuing product line, it has a low need in the CAD engineering data base.

  - Data and drawings are supplied to ED, who does little design, but rather assembles the components and subsystems into the desired customer configuration.

2. CAM AND MANUFACTURING CONTROL: PERCEIVED NEEDS

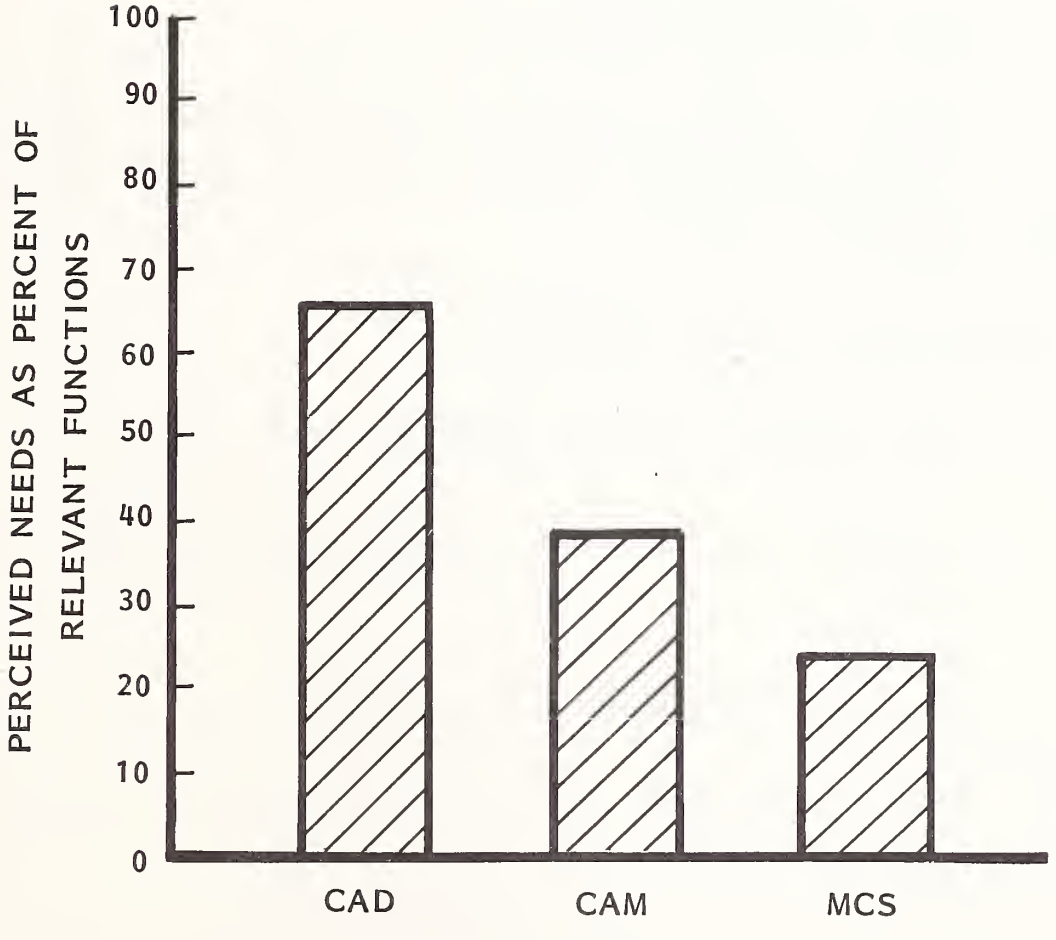
- ED has 350 employees and is growing rapidly.

- The electronic CAM needs are about average for this type of manufacturing.

  - The ED five-year strategic plan lists the anticipated CAM needs.

EXHIBIT VII-4

PERCEIVED CAD/CAM/MCS NEEDS
ELECTRONICS DIVISION: 1981/1982



- The use of automatic insertion CNC equipment plus the reduction in the number of components required because of usage of integrated circuits have permitted the labor content of ED's contract manufacturing to be reduced by a factor of 50% of total system value during the past two years.

  - Management has stated that no major CAM investment is expected until the ED production volume reaches $100 million.

- Data collection for automating incoming inspection is planned.

  - An HP 85 (32K) has been selected.

  - There is no need for WIP or finished products QC data collection because "people are motivated to feed this back to the management quickly."

- Longer range CAM needs include:

  - DNC link from CAD to universal sequence.

  - Automated CAD generated test programs linked (DNC) to DEC test stations.

  - CORDAX compatibility to DEC processors.

  - Communication tie-in from DEC word processing into IBM System/34 MAPICS.

  - Downloading engineering data in IBM parts lists.

C. INITIAL ASSESSMENT FOR CAD/CAM DEVELOPMENT

- The corporate study team has made an initial assessment for CAD/CAM development at each of the AVCO manufacturing divisions.

  - These judgements are based upon:

    . The current status of the divisions.

    . The level of management commitment.

    . The extent of need for CAD/CAM for the division's competitive position.

    . The ability of existing division personnel to accomplish the CAD/CAM objective.

  - Also considered were:

    . Anticipated growth.

    . Age of existing facilities and equipment.

    . Impact of CAD/CAM capabilities on obtaining future business.

    . The potential value of CAD/CAM investment upon the division's current product mix.

1. CAD ASSESSMENT

- The study team believes that ED is fully capable of executing its CAD requirements, as shown in Exhibit VII-5.

EXHIBIT VII-5

ELECTRONICS DIVISION:
STUDY TEAM ASSESSMENT OF CAD/CAM
IN 1981-1982 RELATIVE TO OTHER AVCO DIVISIONS

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	HIGH	HIGH	ABOVE AVERAGE
MANAGEMENT COMMITMENT	HIGH	AVERAGE	AVERAGE
COMPETITIVE POSITION*	AVERAGE	AVERAGE	AVERAGE
IN-HOUSE CAPABILITIES	HIGH	AVERAGE	AVERAGE
ANTICIPATED GROWTH	HIGH	LOW	AVERAGE
EQUIPMENT AGE	NEW	NEW	NEW
IMPACT	HIGH	LOW	AVERAGE
POTENTIAL FOR NEAR-TERM DEVELOPMENT	HIGH	AVERAGE	AVERAGE

*RELATIVE TO EXTERNAL COMPETITION

- In particular the extensive familiarity with DEC software, the 25 DEC programmers and the presence of two graphic programmers put ED above average in software capabilities, the key to CAD success.

- However, there is a question of whether or not sufficient resources exist to meet the requirement for 42,000 drawings in time to meet the deadlines.

2. CAM ASSESSMENT

- ED has made good use of the CAM equipment that is available in the market for electronics assembly manufacture.

  - There is little need for additional CAM at ED, given their current contract base.

  - The overall assessment for CAM at ED is average.

3. MANUFACTURING CONTROL ASSESSMENT

- The anticipated rapid growth of ED will cause the continued development of manufacturing control systems to become more important.

  - The relatively low level of product mix and different part numbers tends to keep MRP relatively simple.

- On balance, the impact of manufacturing control systems upon ED is judged to be about average for the type of industry that it is in.

D. CONCLUSIONS AND RECOMMENDATIONS

- The impact of CAD at ED will be immediate and positive.

- Use of the Applicon system will greatly increase ED's engineering and systems installation capabilities.

- CAD will enhance the division's competitive position by permitting the extensive use of graphic "boilerplate" in its bid and proposal efforts.

- These are significant potential cost savings from CAD that relate to a major segment of ED's business.

- Exhibit VII-6 shows that while CAD will be a very important part of ED's automation push, CAM and manufacturing control potential will be average for the reasons already discussed.

- The study team recommends that ED pursue the development of CAD vigorously.

  - In particular, the link between the DEC-based engineering data base and the IBM-based manufacturing control and CAM systems needs to be integrated.

    . This will permit feedback of production status to proposal and engineering design efforts.

    . It will also promote better utilization of the CAM component sequences, insertion, and test automation equipment.

    . This should be straightforward because all these systems are DEC-based.

- CAM implementation should be based upon the size and nature of ED's manufacturing operations.

- The study team concludes that ED is doing a good job of utilizing CAD/CAM.

EXHIBIT VII-6

ELECTRONICS DIVISION:
OVERALL CONCLUSIONS BY STUDY TEAM

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	HIGH (1)	HIGH	AVERAGE
NEEDS	HIGH	LOW	LOW
POTENTIAL FOR NEAR TERM	HIGH	AVERAGE	AVERAGE

(1) INSTALLATION IN PROGRESS.

- The emphasis on a single, common computer manufacturer (hence data communications compatibility) will pay off handsomely through CAD and CAM integration.

VIII SYSTEMS DIVISION

VIII SYSTEMS DIVISION

A. CAD/CAM STATUS

- The current level of CAD/CAM activity at the Systems Division (SD) has been investigated by the corporate study team.
  - The level is measured against all the potential CAD/CAM functions, as defined in Chapter II, the Executive Summary.
  - Exhibit VIII-1 shows these relationships.
  - These functions are interrelated, as was explained during the initial presentation that was made to SD during its visit to Wilmington on February 5, 1981.
- The needs for CAD/CAM at SD will change substantially following a change in Systems' business toward 50% manufacturing.
- Exhibit VIII-2 shows the areas and levels of existing activity related to CAD, CAM and automated manufacturing control systems.
  - These activities are derived from four primary sources:

EXHIBIT VIII-1

CAD/CAM INTEGRATION

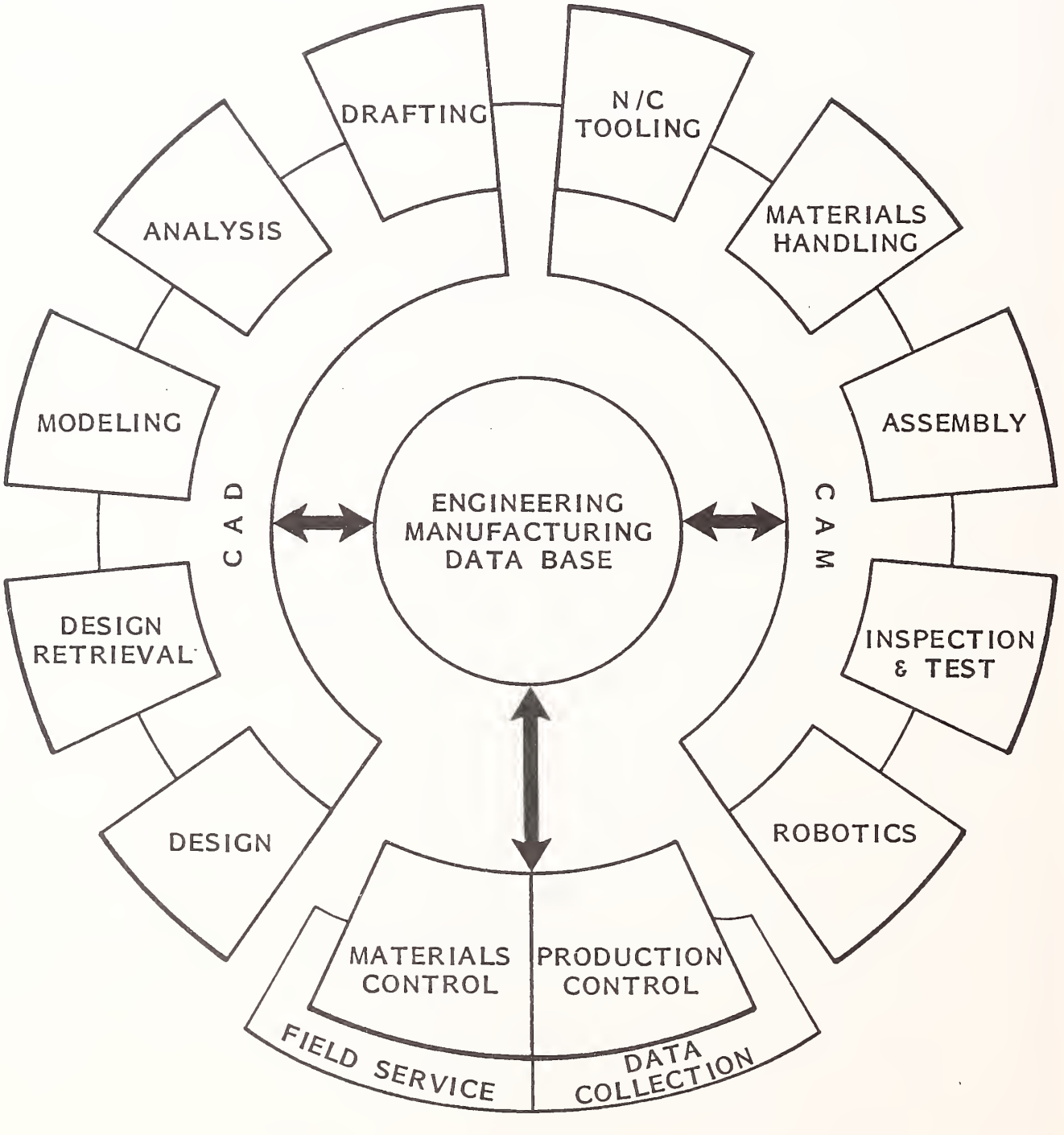


EXHIBIT VIII-2

SYSTEMS DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	STUDY	N/C TOOLS	(1) 12 / 4 (2)	BILL OF MATERIAL	STUDY
SYSTEM GROWTH	X	CNC	4 / 3		
SYSTEM INSTALLATION	X	DNC	X	MATERIAL CONTROL	STUDY
DESIGN		FMC	X		
- MECHANICAL	STUDY			MATERIALS REQ. PLANNING	STUDY
- ELECTRICAL	STUDY	MATERIALS HANDLING			
- ARCHITECTURAL	X	- STORAGE AND RETRIEVAL	*	PURCHASING	STUDY
- TOOLING	STUDY	- WAREHOUSE	*		
- FLAT PATTERN LAYOUT	STUDY	- TOOLING AND GAUGE	*	PROCESS AND ROUTING	STUDY
- DRAFTING	STUDY	- GUIDED VEHICLE SYSTEMS	*		
ANALYSIS		- ROBOT	*	SHOP FLOOR CONTROL	STUDY
- FEA	IN-STALLED	- OTHER	*		
- THERMAL	IN-STALLED			CAPACITY PLANNING	STUDY
- IC	IN-STALLED	ASSEMBLY			
- THREE DIMENSIONAL	STUDY	- ROBOT	*	STANDARD COSTING	STUDY
- OTHER	IN-STALLED	- OTHER	*		

* NO COMPUTER-BASED CAPABILITIES AT PRESENT
(1) NUMBER INSTALLED
(2) AVERAGE AGE
X DOES NOT APPLY TO THIS DIVISION.

EXHIBIT VIII-2 (CONT.)

SYSTEMS DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	STUDY	INSPECTION AND TEST		MASTER SCHEDULING	STUDY
		- ELECTRONIC	2 / 1		
N/C CAPABILITIES		- MECHANICAL	1 / 1	ORDER ENTRY	STUDY
- TAPE PREP	IN-STALLED	- SYSTEMS	1 / 15		
- TOOL OPTIM.	*	- PROCESS	*	FIELD SERVICE	X
ENGINEERING DATA BASE	STUDY			MAINTENANCE CONTROL	STUDY
		ROBOTICS			
MANUFACTURING PROCESS DOC.	STUDY	- WELDING	*	TOOL AND GAUGE CONTROL	IN-STALLED
		- PAINTING	*		
MODELING	IN-STALLED	- OTHER	*	GROUP TECHNOLOGY	*
OTHER	STUDY			FACTORY COLLECTION	
				- BATCH I/O	1 / 1
				- ON-LINE	1 / 3
		FACILITIES MANAGEMENT	*		

- Documented plans that were given to the study team during its initial visit.

- Presentations made by SD management.

- Notes prepared by members of the study team based upon individual and group discussions with SD personnel.

- Trip reports prepared by Norm Bernstein.

- Review of draft report by management and Study Team during second visit to Systems Division on May 21, 1981.

1. CAD STATUS

- Exhibit VIII-2 shows that there is no CAD system in use at Systems Division.

  - A study is underway to establish the divisional CAD requirements and the various alternative means for satisfying these requirements.

  - The current CAD objectives are to:

    - Develop an interactive engineering tool.

    - Begin to evolve an integrated CAD/CAM manufacturing facility.

  - Systems division is planning to install a CAD system in 1982.

2. CAM STATUS

- SD has 2,400 employees and 500,000 square feet of factory space.

- Only 119,000 square feet are used for fabrication and assembly functions.

- The business is such that present activities are mostly engineering with a substantial change toward manufacturing occurring in the 1983-1985 time frame.

- Twelve N/C machines are installed at SD.

3. MANUFACTURING CONTROL STATUS

- There is a high degree of activity in manufacturing control systems development.

  - Several manufacturing resource planning (MRP) systems that have been evaluated to date include COMSERV, COPICS ARISTA, and Software International.

  - COMSERV meets the MRP needs of the Systems Division.

B. CAD/CAM: PERCEIVED NEEDS AND OBJECTIVES

- Exhibit VIII-3 lists the CAD/CAM needs as perceived by SD.

  - The needs are current (1981-1982).

  - The high rating indicates that documentation exists for satisfying the perceived need.

  - A medium rating indicates that this need is perceived, but it may not be in a documented plan.

  - The low rating indicates that this need is under study.

EXHIBIT VIII-3

SYSTEMS DIVISION:

PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	HIGH	N/C TOOLS	HIGH	BILL OF MATERIAL	HIGH
SYSTEM GROWTH	X	CNC	HIGH		
SYSTEM INSTALLATION	X	DNC	X	MATERIAL CONTROL	HIGH
DESIGN		FMC	X		
- MECHANICAL	HIGH			MATERIALS REQ. PLANNING	HIGH
- ELECTRICAL	HIGH	MATERIALS HANDLING			
- ARCHITECTURA.	X	- STORAGE AND RETRIEVAL	*	PURCHASING	HIGH
- TOOLING	MEDIUM	- WAREHOUSE	*		
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE	*	PROCESS AND ROUTING	HIGH
- DRAFTING	HIGH	- GUIDED VEHICLE SYSTEMS	*		
ANALYSIS		- ROBOT	*	SHOP FLOOR CONTROL	HIGH
- FEA	HIGH	- OTHER	*		
- THERMAL	LOW			CAPACITY PLANNING	HIGH
- IC	MEDIUM	ASSEMBLY			
- THREE DIMENSIONAL	HIGH	- ROBOT	*	STANDARD COSTING	HIGH
- OTHER	MEDIUM	- OTHER	MEDIUM		

*NO 1981 PERCEIVED NEEDS

X = DOES NOT APPLY TO THIS DIVISION

EXHIBIT VIII-3 (CONT.)

SYSTEMS DIVISION:
PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	HIGH	INSPECTION AND TEST	X	MASTER SCHEDULING	HIGH
		- ELECTRONIC	HIGH		
N/C CAPABILITIES	X	- MECHANICAL	HIGH	ORDER ENTRY	HIGH
- TAPE PREP	MEDIUM	- SYSTEMS	HIGH		
- TOOL OPTIM.	LOW	- PROCESS	LOW	FIELD SERVICE	X
ENGINEERING DATA BASE	HIGH			MAINTENANCE CONTROL	HIGH
		ROBOTICS	X		
MANUFACTURING PROCESS DOC.	LOW	- WELDING	*	TOOL AND GAUGE CONTROL	HIGH
		- PAINTING	*		
MODELING	HIGH	- OTHER	*	GROUP TECHNOLOGY	LOW
OTHER	HIGH	DATA COLLECTION	X	FACTORY DATA COLLECTION	
		- BATCH I/O	*	- BATCH I/O	HIGH
		- INTERACTIVE	*	- ON-LINE	HIGH
		FACILITIES MANAGEMENT	LOW		

- Where there is an asterisk opposite the function, the need was not perceived to fall within the 1981-1982 timeframe.

- An "X" indicates that the function does not apply to Systems Division, as determined by Systems Division management.

- On a weighted basis, SD ranked first out of six divisions for total CAD/CAM needs.

  - Manufacturing control functions were the most needed with 96% of the applicable MCS perceived needs.

  - CAD systems needs accounted for 80% of the potential CAD functions.

  - Only 36% of the total potential SD needs were expressed for CAM functions.

  - Exhibit VIII-4 shows these relationships.

I. CAD: PERCEIVED NEEDS

- Potential future needs for CAD design automation have been documented in a four-phased CAD development plan.

  - Specific applications for an initial four-workstation standalone CAD system include:

    . MRP to CAD data base interface capability.

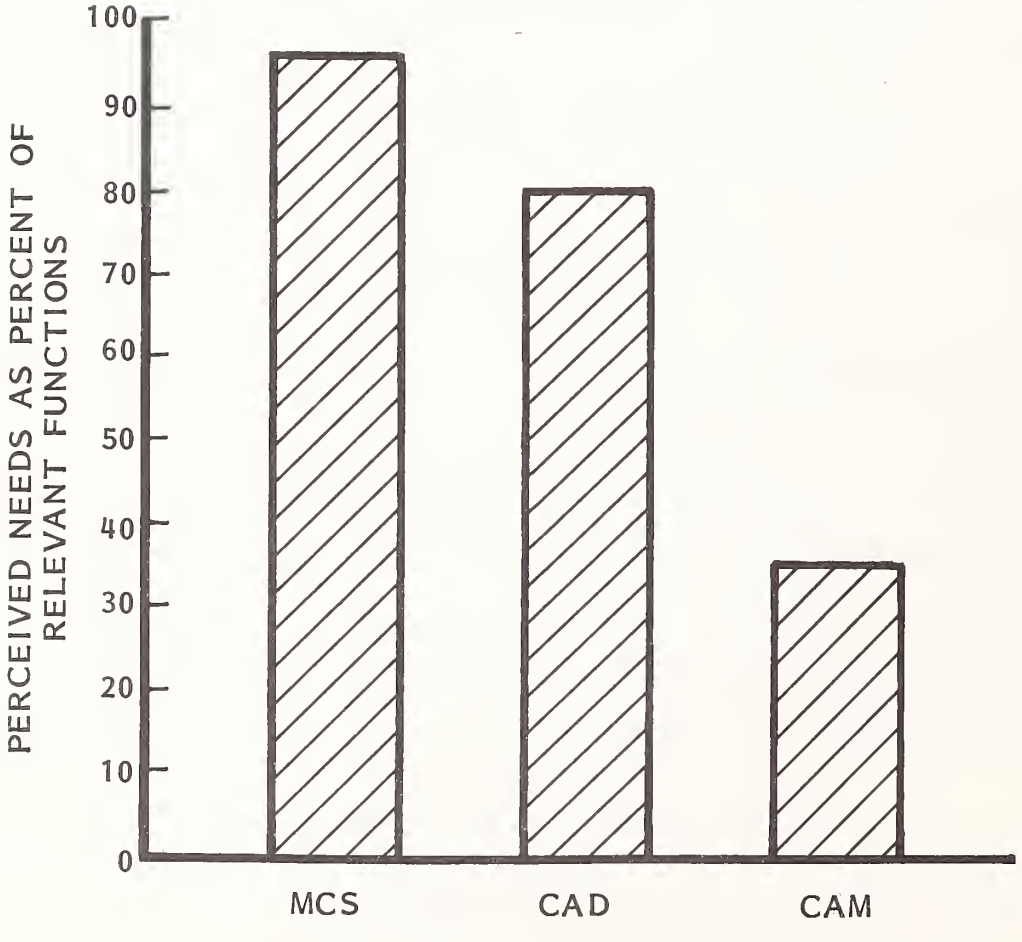
    . Piece part geometric design.

    . Packaging of systems into missile nose cones.

    . PCB layout.

EXHIBIT VIII-4

PERCEIVED CAD/CAM/MCS NEEDS
SYSTEMS DIVISION: 1981/1982



. Circuit layout and analysis.

. Wiring design.

. Development of an on-line engineering data base to be used for both manufacturing CAM and for bid and proposal efforts.

- A longer range need was expressed for CAD facilities planning.

- Engineering design is the most important function of SD at present and for the near future.

  - Sixty-seven percent of the current staff is involved in engineering work.

  - Most of the needs are related to the winning of several critical military electromechanical systems contracts in the near future.

2. CAM: PERCEIVED NEEDS

- In the 1983-1985 timeframe, CAM for PCB assembly and automated systems test will become important.

- Even more importantly, the move into munitions production will create a heavy requirement for CAM.

3. MANUFACTURING CONTROL: PERCEIVED NEEDS

- Current high needs in the manufacturing control systems area include the following:

  - Material requirements planning.

  - Inventory control.

- BOM.
- Order control.
- WIP inventory.
- Shop floor control.
- Capacity planning.
- Standard cost.

- Future needs include development of routing and a configuration control system that would be tied into the CAD engineering data base system.

- Interest in sharing information and experience with other AVCO divisions in the manufacturing control systems development area was expressed by SD management.

C. INITIAL ASSESSMENT FOR CAD/CAM DEVELOPMENT

- The corporate study team has made an initial assessment for CAD/CAM development at each of the AVCO manufacturing divisions.

  - These judgements are based upon:

    . The current status of the divisions.

    . The level of management commitment.

    . The extent of need for CAD/CAM for the division's competitive position.

. The ability of existing division personnel to accomplish the CAD/CAM objective.

- Also considered were:

. Anticipated growth.

. Age of existing facilities and equipment.

. Impact of CAD/CAM capabilities on obtaining future business.

. The potential value of CAD/CAM investment upon the division's current product mix.

I. CAD ASSESSMENT

- SD has high CAD capabilities for engineering and design analyses. Overall CAD capabilities are above average; no in-house CAD systems have been installed yet. This evaluation is shown in Exhibit VIII-5.

- The management commitment to CAD was judged to be high.

- The competitive position is above average since the procurement of CAD is important to acquisition of follow-on programs currently in Advanced Development status.

- The in-house CAD capabilities were estimated to be high.

- The impact of CAD, though strong, will be about average compared to the impact upon other divisions.

- With the increased emphasis on defense procurement, the anticipated growth and the potential for near-term CAD development for the division were judged to be high.

EXHIBIT VIII-5

SYSTEMS DIVISION:
STUDY TEAM ASSESSMENT OF CAD/CAM
IN 1981-1982 RELATIVE TO OTHER AVCO DIVISIONS

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	AVERAGE (1)	AVERAGE	LOW
MANAGEMENT COMMITMENT	HIGH	HIGH	HIGH
COMPETITIVE POSITION*	ABOVE AVERAGE	LOW	LOW
IN-HOUSE CAPABILITIES	HIGH	AVERAGE	ABOVE AVERAGE
ANTICIPATED GROWTH	HIGH	HIGH	HIGH
EQUIPMENT AGE	NEW(1)	AVERAGE	NEW
IMPACT	AVERAGE	AVERAGE	HIGH
POTENTIAL FOR NEAR-TERM DEVELOPMENT	HIGH	AVERAGE	HIGH

*RELATIVE TO EXTERNAL COMPETITION

(1) USING IBM 3033; NO TURNKEY CAD

2. CAM ASSESSMENT

- SD has not been a volume producer of hardware at any time during the 25-year history of the division.
  - However, the emphasis and commitment to CAM is high, as shown in Exhibit VIII-5.
  - Expected contracts for military systems, including the MX Re-entry System, indicate a substantial increase in manufacturing activity.
  - Beginning in 1983 CAM will become important to SD.
  - CAM is important to acquisition of follow-on programs that are currently in advanced development and full scale Engineering Development status.
- A major advantage of CAM for SD is that it will not be necessary to take out existing production equipment in order to implement CAM when it is needed.
- There has been an on-going program of acquisition of N/C machines.
  - In 1979 two CNC machines were acquired.
  - In 1980 two additional CNC machines were acquired that included a horizontal machining center.
- 1981 CAM plans include the acquisition of a 4-axis machining center.
  - Substantial growth in N/C machine tool development is anticipated in the 1983-1985 time period.

3. MANUFACTURING CONTROL ASSESSMENT

- The current level of involvement in manufactuing control systems development is high due to the substantial change in SD's business towards manufacturing.

  - Management commitment to manufacturing control systems implementation is high.

  - Because of the very strong computer service bureau installation at SD, the potential for developing and installing the manufacturing software systems that may be required in the future were judged to be above average.

  - Detailed plans have been documented for MRP installation in 1981. These are further evidence of SD's commitment to manufacturing control system developments.

- In the near term, manufacturing control development will be high.

D. CONCLUSIONS AND RECOMMENDATIONS

- SD is in the process of repositioning their business mix to a 50% manufacturing environment over the next five years. In order to support this major change, SD is developing detailed plans and support teams for the required CAD/CAM activities. In many instances the potential near term development (1981-82) can only be judged as each milestone of the various plans is reached.

- In some areas such as CAM the significant build-up will take place in the 1983-84 time frame, thus only an average potential for near term development for 1981-82. As shown in Exhibit VIII-6 both the CAD and Manufacturing Control are given a high ranking since there are (will be) measurable activities during the 1981-82 timeframe.

IX METALWORKING LASER DIVISION

EXHIBIT VIII-6

SYSTEMS DIVISION:
OVERALL CONCLUSIONS BY STUDY TEAM

	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	HIGH	AVERAGE	LOW
NEEDS	HIGH	BELOW AVERAGE	HIGH
POTENTIAL FOR NEAR TERM	HIGH	LOW	HIGH

IX METALWORKING LASER DIVISION

A. CAD/CAM STATUS

- The AVCO Metalworking Laser Division (MLD) has no CAD or CAM equipment or systems currently in place.
  - This is because the product of the division is a custom, one-of-a-kind metalworking laser machine that sells for approximately $1 million each.
  - The current production volume is about two systems per year.
- Neither the size of the operation nor the nature of the product has dictated the installation of CAD or CAM systems.
  - MLD is in a start-up mode, making equipment justification difficult at this stage.
- Exhibit IX-1 indicates the lack of CAD/CAM activity.

EXHIBIT IX-1

METALWORKING LASER DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	STUDY	N/C TOOLS	(1) X / X (2)	BILL OF MATERIAL	X
SYSTEM GROWTH	X	CNC	X / X		
SYSTEM INSTALLATION	X	DNC	X / X	MATERIAL CONTROL	X
DESIGN		FMC	X / X		
- MECHANICAL	STUDY			MATERIALS REQ. PLANNING	X
- ELECTRICAL	X	MATERIALS HANDLING			
- STRUCTURAL	STUDY	- STORAGE AND RETRIEVAL	X	PURCHASING	X
- TOOLING	X	- WAREHOUSE	X		X
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE	X	PROCESS AND ROUTING	X
- DRAFTING	STUDY	- GUIDED VEHICLE SYSTEM	X		
ANALYSIS		- ROBOT	X	SHOP FLOOR CONTROL	X
- FEA	X	- OTHER	X		
- THERMAL	X			CAPACITY PLANNING	X
- IC	X	ASSEMBLY			
- THREE DIMENSIONAL	STUDY	- ROBOT	X	STANDARD COSTING	X
- OTHER	X	- OTHER	X		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT

(1) NUMBER INSTALLED

(2) AVERAGE AGE

X = DOES NOT APPLY TO THIS DIVISION

EXHIBIT IX-1 (CONT.)

METALWORKING LASER DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	X	INSPECTION AND TEST		MASTER SCHEDULING	X
		- ELECTRONIC	X		
N/C CAPABILITIES		- MECHANICAL	X	ORDER ENTRY	X
- TAPE PREP	X	- SYSTEMS	X		
- TOOL OPTIM.	X	- PROCESS	X	FIELD SERVICE	X
ENGINEERING DATA BASE	X			MAINTENANCE CONTROL	X
		ROBOTICS			
MANUFACTURING PROCESS DOC.	X	- WELDING	X	TOOL AND GAUGE CONTROL	X
		- PAINTING	X		
MODELING	X	- OTHER	X	GROUP TECHNOLOGY	X
OTHER	X			FACTORY DATA COLLECTION	
				- BATCH I/O	X
				- ON-LINE	X
		FACILITIES MANAGEMENT	X		

B. CAD/CAM: PERCEIVED NEEDS

- The management of MLD indicated to the corporate study team that they believe they have a high need for a CAD system.
  - Their functional needs are shown in Exhibits IX-2.
- MLD currently employs six draftsmen.
  - They are continually having to change laser system drawings because the purchasers' configuration needs change during the negotiations and during the building of their laser systems.
  - CAD could reduce the cost of redrawing.
- The need for 3-D analysis is based upon complicated angles of reflection and splitting of the laser beam.
  - To determine how a design change affects the beam direction requires 3-D analysis.
  - CAD could greatly simplify analysis of these changes.
- Other CAD functions include:
  - Fast generation of standard laser configurations for proposals using CAD design retrieval.
- There are no current CAM or automated manufacturing control needs.
- Only two systems were sold in the past year.

EXHIBIT IX-2

METALWORKING LASER DIVISION:
PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	X	N/C TOOLS	X	BILL OF MATERIAL	X
SYSTEM GROWTH	X	CNC	X		
SYSTEM INSTALLATION	X	DNC	X	MATERIAL CONTROL	X
DESIGN		FMC	X		
- MECHANICAL	X			MATERIALS REQ. PLANNING	X
- ELECTRICAL	X	MATERIALS HANDLING			
- STRUCTURAL	X	- STORAGE AND RETRIEVAL	X	PURCHASING	X
- TOOLING	X	- WAREHOUSE	X		
- OPTICAL	HIGH	- TOOLING AND GAUGE	X	PROCESS AND ROUTING	X
- DRAFTING	HIGH	- GUIDED VEHICLE SYSTEM	X		
ANALYSIS		- ROBOT	X	SHOP FLOOR CONTROL	X
- FEA	X	- OTHER	X		
- THERMAL	X			CAPACITY PLANNING	X
- IC	X	ASSEMBLY			
- THREE DIMENSIONAL	HIGH	- ROBOT	X	STANDARD COSTING	X
- OTHER	X	- OTHER	X		

*NO 1981 PERCEIVED NEEDS
X = DOES NOT APPLY TO THIS DIVISION

EXHIBIT IX-2 (CONT.)

METALWORKING LASER DIVISION:

PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	X	INSPECTION AND TEST		MASTER SCHEDULING	X
		- ELECTRONIC	X		
N/C CAPABILITIES		- MECHANICAL	X	ORDER ENTRY	X
- TAPE PREP	X	- SYSTEMS	X		
- TOOL OPTIM.	X	- PROCESS	X	FIELD SERVICE	X
		CAM INTEGRATION	X		
ENGINEERING DATA BASE	X			MAINTENANCE CONTROL	X
		ROBOTICS			
MANUFACTURING PROCESS DOC.	X	- WELDING	X	TOOL AND GAUGE CONTROL	X
		- PAINTING	X		
MODELING	X	- OTHER	X	GROUP TECHNOLOGY	X
OTHER	X			FACTORY DATA COLLECTION	
				- BATCH I/O	X
				- ON-LINE	X
		FACILITIES MANAGEMENT	X		

- Future expectations of up to one system per month are still too low for CAM and manufacturing control justification.

C. INITIAL ASSESSMENT FOR CAD/CAM DEVELOPMENT

- Exhibit IX-3 shows that management interest in CAD is high but that in-house capabilities to use a CAD system are low.

  - The size of the operation is too small to generate better than a below average CAD impact upon MLD.

- Neither CAM nor manufacturing control is expected to be required at MLD for the reason noted in Section B above.

D. CONCLUSIONS AND RECOMMENDATIONS

- Because of the low production volume and the lack of existing CAD/CAM equipment, the study team concluded that the potential for CAD/CAM is low both in the near term and over the next five years.

  - The only exception is that some form of CAD assistance may be justified when the production volume increases.

- The study team recommends that CAD developments, especially at Systems Division, be communicated to MLD.

EXHIBIT IX-3

METALWORKING LASER DIVISION:
STUDY TEAM ASSESSMENT OF CAD/CAM
IN 1981-1982 RELATIVE TO OTHER AVCO DIVISIONS

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	NONE	NONE	NONE
MANAGEMENT COMMITMENT	HIGH	N/A	N/A
COMPETITIVE POSITION*	N/A	N/A	N/A
IN-HOUSE CAPABILITIES	LOW	LOW	LOW
ANTICIPATED GROWTH	ABOVE AVERAGE	LOW	LOW
EQUIPMENT AGE	N/A	N/A	N/A
IMPACT	BELOW AVERAGE	LOW	LOW
POTENTIAL FOR NEAR-TERM DEVELOPMENT	LOW	LOW	LOW

*RELATIVE TO EXTERNAL COMPETITION

- Because of the proximity of the Systems Division, the possibility that MLD could utilize System Division's CAD system when it is installed certainly exists.

- A remote CAD workstation to a graphics service bureau is another possibility that should be investigated.

- The study team also believes that the cost of standalone CAD automated drawing systems that have limited internal computational power will become available within the next several years.

  - These systems will allow MLD to automate its drawing requirements for less than $75,000.

  - Typical CAD systems today cost $300,000 and more.

  - Exhibit IX-4 summarizes the study team's overall conclusions.

EXHIBIT IX-4

METALWORKING LASER DIVISION:
OVERALL CONCLUSIONS BY STUDY TEAM

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	NONE	NONE	NONE
NEEDS	BELOW AVERAGE	NONE	NONE
POTENTIAL FOR NEAR TERM	LOW	LOW	LOW

X SPECIALTY MATERIALS DIVISION

X SPECIALTY MATERIALS DIVISION

A. CAD/CAM STATUS

- The AVCO Specialty Materials Division (SMD) has limited CAD or manufacturing control activity at the present time.

- As shown in Exhibit X-1, one approximation of a CAM system at SMD consists of a microprocessor system that processes boron fiber test data and displays results in both tabular and graphic form.

- Another process automation feature is a mechanism that cuts fibers as they are being gathered on a single roll for impregnation. This design transfers from a full roll to an empty one without halting the machine that gathers the threads together.

- Exhibit X-1 summarizes the SMD current CAD/CAM activities.

B. CAD/CAM: PERCEIVED NEEDS

- No need for CAD/CAM investment is currently perceived by SMD management.

EXHIBIT X-1

SPECIALTY MATERIALS DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	X	N/C TOOLS	(1) X / N/A (2)	BILL OF MATERIAL	X
SYSTEM GROWTH	X	CNC	X / N/A		
SYSTEM INSTALLATION	X	DNC	X / N/A	MATERIAL CONTROL	X
DESIGN		FMC	X / N/A		
- MECHANICAL	X			MATERIALS REQ. PLANNING	X
- ELECTRICAL	X	MATERIALS HANDLING			
- STRUCTURAL	X	- STORAGE AND RETRIEVAL	X	PURCHASING	*
- TOOLING	X	- WAREHOUSE	X		
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE	X	PROCESS AND ROUTING	X
DRAFTING	X	- GUIDED VEHICLE SYSTEM	X		
		- ROBOT	X	SHOP FLOOR CONTROL	X
ANALYSIS FEA	IN-STALLED	- OTHER	X		
ANALYSIS THERMAL	X			CAPACITY PLANNING	X
ANALYSIS IC	X	ASSEMBLY			
ANALYSIS 3D	X	- ROBOT	X	STANDARD COSTING	X
ANALYSIS OTHER	X	- OTHER	X		

*NO COMPUTER-BASED CAPABILITIES AT PRESENT

(1) NUMBER INSTALLED

(2) AVERAGE AGE

X = DOES NOT APPLY TO THIS DIVISION

EXHIBIT X-1 (CONT.)

SPECIALTY MATERIALS DIVISION:
CURRENT CAD/CAM ACTIVITIES

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	X	INSPECTION AND TEST		MASTER SCHEDULING	X
		- ELECTRONIC	X		
N/C CAPABILITIES		- MECHANICAL	IN-STALLED	ORDER ENTRY	X
- TAPE PREP	X	- SYSTEMS	X		
- TOOL OPTIM.	X	- PROCESS	IN-STALLED	FIELD SERVICE	X
ENGINEERING DATA BASE	X			MAINTENANCE CONTROL	*
		ROBOTICS			
MANUFACTURING PROCESS DOC.	X	- WELDING	X	TOOL AND GAUGE CONTROL	X
		- PAINTING	X		
MODELING	*	- OTHER	X	GROUP TECHNOLOGY	X
OTHER	X			FACTORY DATA COLLECTION	
				- BATCH I/O	*
				- ON-LINE	X
		FACILITIES MANAGEMENT	X		

- The current products are boron fibers, fire protection chemicals and graphite material processing.

  - These products are produced by a combined chemical process and textile fiber type of machinery.

  - The nature of their business does not justify investment in CAD/CAM.

- The facility employes 150 people.

- Exhibit X-2 summarizes SMD's perceived needs.

C. INITIAL ASSESSMENT FOR CAD/CAM DEVELOPMENT

- As indicated in Exhibit X-3, the impact of CAD/CAM at SMD is expected to be below average compared to the other AVCO manufacturing divisions.

  - Any automation is more likely to be akin to process automation in the textile industry.

  - As such, SMD is distinct from other AVCO divisions.

D. CONCLUSIONS AND RECOMMENDATIONS

- The study team concludes that SMD be kept informed of CAD/CAM developments generally within AVCO.

  - Should a need arise, SMD can benefit from others' experience.

EXHIBIT X-2

SPECIALTY MATERIALS DIVISION:
PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
SYSTEM SELECTION	X	N/C TOOLS	X	BILL OF MATERIAL	X
SYSTEM GROWTH	X	CNC	X		
SYSTEM INSTALLATION	X	DNC	X	MATERIAL CONTROL	X
DESIGN		FMC	X		
- MECHANICAL	X			MATERIALS REQ. PLANNING	X
- ELECTRICAL	X	MATERIALS HANDLING			
- STRUCTURAL	X	- STORAGE AND RETRIEVAL	X	PURCHASING	X
- TOOLING	X	- WAREHOUSE	X		
- FLAT PATTERN LAYOUT	X	- TOOLING AND GAUGE	X	PROCESS AND ROUTING	X
- DRAFTING	X	- GUIDED VEHICLE SYSTEM	X		
ANALYSIS		- ROBOT	X	SHOP FLOOR CONTROL	X
- FEA	X	- OTHER	X		
- THERMAL	X			CAPACITY PLANNING	X
- IC	X	ASSEMBLY			
- THREE DIMENSIONAL	X	- ROBOT	X	STANDARD COSTING	X
- OTHER	X	- OTHER	X		

*NO 1981 PERCEIVED NEEDS

EXHIBIT X-2 (CONT.)

SPECIALTY MATERIALS DIVISION:
PERCEIVED CAD/CAM NEEDS FOR 1981-1982

CAD		CAM		MANUFACTURING CONTROL	
DESIGN RETRIEVAL	X	INSPECTION AND TEST		MASTER SCHEDULING	X
		- ELECTRONIC	X		
N/C CAPABILITIES		- MECHANICAL	X	ORDER ENTRY	X
- TAPE PREP	X	- SYSTEMS	X		
- TOOL OPTIM.	X	- PROCESS	LOW	FIELD SERVICE	X
ENGINEERING DATA BASE	X			MAINTENANCE CONTROL	X
		ROBOTICS			
MANUFACTURING PROCESS DOC.	X	- WELDING	X	TOOL AND GAUGE CONTROL	X
		- PAINTING	X		
MODELING	X	- OTHER	X	GROUP TECHNOLOGY	X
OTHER	X			FACTORY DATA COLLECTION	
				- BATCH I/O	X
				- ON-LINE	X
		FACILITIES MANAGEMENT	*		

EXHIBIT X-3

STUDY TEAM ASSESSMENT OF CAD/CAM SUCCESS IN 1981-1982 RELATIVE TO OTHER AVCO DIVISIONS

CRITERION	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	N/A	LOW	LOW
MANAGEMENT COMMITMENT	N/A	HIGH	AVERAGE
COMPETITIVE POSITION*	N/A	N/A	N/A
IN-HOUSE CAPABILITIES	LOW	AVERAGE	LOW
ANTICIPATED GROWTH	BELOW AVERAGE	ABOVE AVERAGE	LOW
EQUIPMENT AGE	N/A	2 YEARS	N/A
IMPACT	BELOW AVERAGE	BELOW AVERAGE	LOW
POTENTIAL FOR NEAR-TERM DEVELOPMENT	N/A	N/A	N/A

*RELATIVE TO EXTERNAL COMPETITION

- As shown in Exhibit X-4, the potential for CAD/CAM at SMD is minimal, except for some process control automation as discussed in Section B above.

- SMD should consider providing a CAD service for customer design and analysis support.

  - The division should contact AVCO Computer Services at the Systems Division to explore potential support capabilities.

EXHIBIT X-4

SPECIALTY MATERIALS DIVISION:
OVERALL CONCLUSIONS BY STUDY TEAM

	CAD	CAM	MANUFAC-TURING CONTROL
CURRENT STATUS	NONE	NONE	NONE
NEEDS	NONE	PROCESS CONTROL	NONE
POTENTIAL FOR NEAR TERM	N/A	N/A	N/A

APPENDIX: CAD/CAM GLOSSARY OF TERMS

APPENDIX: CAD/CAM GLOSSARY OF TERMS

ANALYSIS FEA. The use of a CAD system for finite element analysis to test for structural stress capabilities of a part or assembly.

ANALYSIS IC. The use of a CAD system to assist in the design of electronic integrated circuits.

ANALYSIS OTHER. The use of a CAD system to generate non-engineering data such as project control charts. The use of CAD to communicate graphic and parts data from one location to another.

ANALYSIS THERMAL. The use of a CAD system to analyze the thermal characteristics of an assembly in its operating environment.

ANALYTICAL MODELING. A technique used to represent mathematically (usually by a set of equations) some physical phenomena. Such models are valuable for abstracting the essence of the subject of inquiry. Because equations describing complex systems tend to become complicated and often impossible to formulate, it is usually necessary to make simplifying assumptions, which may distort accuracy.

APPLICATION PACKAGE. A set of programs specifically designed to perform a particular application. The working programs in a system for a user task may be classified as an "application package."

APPLICATION PROGRAMS. Computer programs devised for a specific task.

APPLICATION SOFTWARE. Software designed to operate as a system for specific applications; e.g., the software for an INTERACTIVE GRAPHICS system to carry out printed circuit board artwork layout.

APT. (Automatically programmed tools) An English-like language which describes the part illustrated on an engineering drawing and takes the form of a sequence of statements that define the part of geometry and machine tool cutter operations.

ARCHITECTURE. A framework or structure which determines how something is constructed, defining modularity and interfaces among modules: preset, physical and logical arrangement of a computer.

ASCII. American Standard Code for Information Interchange.

ASSEMBLY. The physical fitting together of fabricated parts into a complete machine structure or unit.

AUTOMATED ASSEMBLY. Assembly by means of operations performed automatically by machines. A computer system may monitor and/or control the production and quality levels of the assembly operations.

AUTOMATIC DATA PROCESSING. Data processing by electronic computers and tabulating equipment to produce desired results with a minimum of human effort.

AUTOMATIC DRAFTING. The generation of engineering drawings or artwork masters from data base descriptions of a real artifact.

BATCH MODE PROCESSING. A technique by which items to be processed must be coded and collected into groups prior to processing.

BATCH PRODUCTION. Noncontinuous processing of unlike parts.

BILL OF MATERIAL (BOM). A listing of all the subassemblies, parts, and materials that go into an assembled product showing the quantity of each required to make on assembly.

CAD/CAM (COMPUTER-AIDED DESIGN/COMPUTER-AIDED MANUFACTURING). Computer-aided design programs allow parts designers to both structure and test parts and assemblies before manufacture. Computer-aided manufacturing computers support employees and equipment during the manufacturing process.

COMPUTER-AIDED DESIGN (CAD). A design or drafting system whereby an operator interacts with a computer system to carry out a function. The computer serves as a calculation, storage, record-keeping and formatting device, but does not make decisions. Any system that uses a computer to assist in the creation or modification of a design.

COMPUTER-AIDED MANUFACTURING (CAM). Any manufacturing operation that is computer-aided; the effective utilization of computer technology in the management control; either direct or indirect computer interface with the physical and human resources of the company.

COMPUTER-AIDED DESIGN (CAD)/COMPUTER-AIDED MANUFACTURING (CAM) INTEGRATION. The concept of grouping computer-based data and equipment into a single system. Monitoring and control of the system include feedback and feed-forward process control concepts.

COMPUTER GRAPHICS. That branch of science and technology concerned with methods and techniques for converting any form of information to or from graphic representation via a computer.

COMPUTER NUMERICAL CONTROL (CNC). The use of a dedicated computer within a numerical control unit with the capability of local data input. It may become part of a DNC system by direct link to a central computer.

DATA BASE. A collection of data fundamental to an enterprise, comprised of comprehensive files of information having predetermined structure and organization and suitable for communication, interpretation or processing by human or automatic means.

DATA COLLECTION. The act of bringing data from one or more points to a central point.

DESIGN RETRIEVAL. The use of a CAD system to store design and engineering data so it can be accessed by engineering and production personnel via computer terminals.

DIRECT NUMERICAL CONTROL (DNC). The use of a shared computer for distribution of part program data via data lines to remote machine tools.

EO. Engineering Order.

FABRICATION. A term used to distinguish production operations for components as opposed to assembly operations.

FACILITIES MANAGEMENT. A computer-based system for monitoring and controlling the factory facilities. Examples include energy management, security, fire safety, lighting, pollution, and access.

FACTORY DATA COLLECTION. Used to gather data from the factory floor through terminals that are connected to a central computer.

FLEXIBLE MACHINE CENTER (FMS). A group of machines that are controlled by dedicated computer(s) and which are fed the parts for assembly or fabrication by a coordinated materials handling system.

GRAPHIC DISPLAY. A raster scan, DVST, plasma, or vector display that can present an image to the user which has been computer generated.

GROUP TECHNOLOGY. The means of coding parts on the basis of similarities of parts. The grouping of parts into production families based upon similarities in their production so that the parts in a particular "family" could then be processed together. The grouping of diverse machines together to produce a particular family of parts.

GUIDED VEHICLE SYSTEM. Automated delivery of parts, assemblies, tool, jigs, etc. throughout the factory flow by means of an unmanned vehicle.

HOST COMPUTER. The host computer is that part of the hardware which processes interrupts and data from various satellite intelligent terminals or data-entry devices.

INSTALLATION. The process of installing, testing, being trained to use, and the acceptance of equipment.

INTERACTIVE. Processing of data on a two-way basis, and with human intervention providing redirection of processing in a predetermined manner.

MACHINE CENTER, FLEXIBLE (FMS). A group of similar machines which can all be considered together for the purposes of loading.

MAINTENANCE CONTROL. A computer-based, real-time system for monitoring equipment utilization and for generating preventive maintenance schedules and work orders.

MANAGEMENT INFORMATION SYSTEMS (MIS). Management performed with the aid of automatic data processing. An EDP system specifically designed to provide business management with company, financial or project data on an as-requested or real-time basis.

MANUFACTURING PROCESS DOCUMENTATION. The use of a CAD system to generate data for manufacturing processes that are required for fabrication and/or assembly of the part while it is being designed.

MATERIAL CONTROL. The technique of maintaining items at desired levels, whether they be raw materials, work-in-process, or finished products.

MODEL. A representation of a real situation, procedure or ideal technique in a symbolic form. It can take the form of an equation, graphic analogue or a narrative sequence.

N/C TOOL OPTIMIZATION. The use of a CAD system to display, analyze and modify N/C programs with the objective of maximization of machine tool fabrication time and reduction of tool and part movements.

NUMERICAL CONTROL (N/C). The field of computer activity which centers around the control of machine tools by mechanical devices; e.g., a computer to control a cutting tool to mill a part.

ORDER ENTRY. A computer-based system for producing information and authorization to purchase, sell or supply goods.

PROCESS CONTROL. Pertaining to systems whose purpose is to provide automation of continuous operations. This is contrasted with numerical control (N/C) which provides automation of discrete operations.

POST PROCESSOR. A program that produces output for a specific machine; e.g., paper tape for an N/C cutting machine using well-defined input produced by a general processor program (e.g., APT).

PROCESS AND ROUTING. Using computer systems to develop the sequence of operations to be performed in order to produce a part or an assembly.

PRODUCTION CAPACITY PLANNING. The function of setting the limits or levels of manufacturing operations in the future, consideration being given to sales forecasts and the requirements and availability of man, machines, materials and money.

ROBOT. An automatic apparatus or device with manipulative capabilities that permit the performance of functions ordinarily ascribed to humans.

SCHEDULING, MASTER. The process of setting operation start dates for jobs to be processed through work centers, departments, and factories that allow the jobs to be completed by their due date.

SHOP FLOOR CONTROL. Control of the progress of each customer order or stock order through the successive operations of its production cycle, assignment of specific job orders to men and machines and the collection of data regarding actual completion results.

STANDARD COSTING. A method of establishing or predicting what costs should be under projected conditions such as wage rates, methods and lot sizes.

STRUCTURAL DESIGN. The use of CAD for architectural and engineering/construction types or design and engineering analysis.

SYSTEM GROWTH. The process of adding more hardware and/or software capabilities to an installed CAD system.

SYSTEM SELECTION. The process of defining needs, evaluating vendor systems, selecting a CAD system and negotiating for the purchase of a CAD system.

THREE DIMENSIONAL (3-D). Presentation in graphical form of three dimensional objects. Various types of projections exist to reduce 3-D to 2-D drawings (isometric, perspective, etc.).

TOOLING. A set of required standards of special tools for production of a particular part, including jigs, fixtures, gauges, holding tools, etc. Specifically excludes machine tools.

TURNKEY SYSTEM. A term applied to a computer system whereby a supplier has total responsibility for building, installing and testing the system, including both hardware and software.

TWO AND A HALF DIMENSIONAL (2½-D) AND FIVE DIMENSIONAL (5-D). Used in conjunction with machine tool control, 2½ or 2+ indicates control in the two major axes simultaneously with depth. 5-D indicates five-axes output for machining centers that in addition have multiple tool selection and control.